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January 3, 2014

FG-02-LET-0022

Jeffrey R. McDonald, Geologist
Underground Injection Control Branch
U.S. EPA – Region 5
77 West Jackson Boulevard
Mail Code: WU-16J
Chicago, IL 60604-3507

Dear Jeff:

DOE AWARD NO: DE-FE0001882, Project 60549, ARRA Technical Support to FutureGen Industrial Alliance, Request for Additional Information #4

Please find attached our responsed to your email request for additional information (RAI 4) dated December 23, 2013 on the FutureGen Alliance's UIC permit application.

Please call if you have any questions.

Sincerely,

Tyler Gilmore
Battelle Manager FutureGen Storage Site
Pacific Northwest National Laboratory

TG/dmt
Attachment

cc: Ken Humphreys, CEO, FutureGen Alliance, Inc.
Lucinda Swartz, COO, FutureGen Alliance, Inc.

File

12-20-2013: Email from Jeff McDonald (U.S. EPA Region 5) to Tyler Gilmore (Alliance): "FGA FR and other requests: 12-20-2013"

Requests based on the text application

RAI #	Subject	Page	Doc. Sec.	Par.	EPA Comment / Question / Request	FutureGen Response	Footnote / Reference Citation
12-20-2013_001	References				"The Final EIS referenced document "Battelle. 2011a. Environmental Information Volume Biological Resources Section. Prepared for FutureGen Alliance. October 2011." Please provide a copy of this document. Submission of the document in electronic format is acceptable and encouraged.""	The referenced document in the Final EIS is provided in the data package transmitted to EPA via MassTransit© with this response. The corresponding folder name in the transmitted data package is **12-20-2013_001-EIV_Biological_Res_Section.** Please note that the Environmental Information Volume "Biological Resources Section" includes Appendices A, B, and C in the master file (*FutureGen--Biological Resources EIV_October_2011.pdf).* Appendices D and E are provided separately.	
12-20-2013_002	References				"Please provide a copy of all references cited in the application. Please also provide a copy of all references cited in the responses to EPA requests for additional information. Submission of the documents in electronic format is acceptable and encouraged."	**1) References cited in the Supporting Documentation of the UIC Permit Application** Appendix A is a compilation of the reference lists from each chapter of the FutureGen 2.0 UIC permit application. At EPA's request, copies of referenced material are being provided if the documents are not copyright protected. Copies of federal and state regulations are not included. Blue highlighted text indicates documents provided to EPA via MassTransit© with this response, in the folder **12-20-2013_002-UIC_Permit_References**. If the documents are copyright protected, hyperlinks are provided whenever possible to websites where the document can be read or where it can be purchased. There are a few instances where documents are copyright protected and exist only in hard copy form, and those are noted as such. **2) References in the Request for Additional Information #1 (10-31-2013)** a. The references related to the Seismic Reflection Survey and Vertical Seismic Profiling Data (RAI# 10-31-2013_001) are not published and cannot be released. However, the FutureGen Industrial Alliance, Inc. (Alliance) is open to any discussion with EPA related to this topic. b. In the response to RAI 10-31-2013_004 (Horizontal Components of Stress), both references are copyrighted material (limited information regarding these references is available in Appendix B). **3) References in the Request for Additional Information #2 (11-14-2013)** **a. References related to the Capillary Pressure and Saturation Functions (11-14-2013_005)** Data from the Manlove field used to generate Brooks-Corey parameters cannot be provided by the Alliance to the EPA. The Alliance suggests that the EPA request the data from ISGS (Sallie Greenberg or Scott Frailey might be good contacts). **b. References for other responses** Appendix B is a compilation of the reference lists from the responses to the EPA's RAIs (10-31-2013 and 11-14-2013). The documents used for the responses to the EPA's RAIs are all copyright protected and cannot be provided to the EPA. Hyperlinks are included whenever possible to websites where the document can be read or where it can be purchased. There are a few instances where documents are copyright protected and exist only in hard copy form, and those are noted as such.	

12-20-2013: Email from Jeff McDonald (U.S. EPA Region 5) to Tyler Gilmore (Alliance): "FGA FR and other requests: 12-20-2013"							
Requests based on the text application							
RAI #	**Subject**	**Page**	**Doc. Sec.**	**Par.**	**EPA Comment / Question / Request**	**FutureGen Response**	**Footnote / Reference Citation**
12-20-2013_003	Construction Procedures and Plugging and Abandonment Plans for the Monitoring Wells				"Please submit individual construction procedures and plugging and abandonment plans for each of the five monitoring wells that include the third-party cost estimates for each well. We saw cost estimates on pages C-11 and C-12 of the application. If these were developed from a third party, we'd like to see what they submitted for you to generate those tables."	Construction procedures and plugging abandonment plans are provided in **Appendix C.** A discussion and location map of the updated and revised monitoring well network is also provided in **Appendix C**, along with cost estimate information.	

Appendix A

RAI 12-20-2013_002

Additional Information Regarding

References used in the Supporting Documentation of the UIC Permit Applications

This is a compilation of the reference lists from each chapter of the Supporting Documentation of the UIC permit applications. At EPA's request, copies of referenced material are being provided if the documents are not copyright protected. Copies of federal and state regulations are not included. Blue highlighted text indicates documents provided via MassTransit© with this response. If the documents are copyright protected, hyperlinks are provided whenever possible to websites where the document can be read or where it can be purchased. There are a few instances where documents are copyright protected and exist only in hard copy form, and those are noted as such.

1. Chapter 1 References

40 CFR 144. Code of Federal Regulations, Title 40, *Protection of the Environment*, Part 144 "Underground Injection Control Program," Section 31, "Application for a Permit; Authorization by Permit." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.6.

40 CFR 146. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 146, "Underground Injection Control Program: Criteria and Standards." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.8.

75 FR 77230. December 10, 2010. "Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells." *Federal Register*. Environmental Protection Agency. Available online at www.gpo.gov/fdsys/pkg/FR-2010-12-10/pdf/2010-29954.pdf.

76 FR 29728. May 23, 2011. "Notice of Intent to Prepare an Environmental Impact Statement and Notice of Potential Floodplain and Wetlands Involvement for the FutureGen 2.0 Program." *Federal Register*. U.S. Department of Energy. Available online at http://www.gpo.gov/fdsys/pkg/FR-2011-05-23/pdf/2011-12632.pdf.

American Recovery and Reinvestment Act of 2009 (ARRA). Public Law 111-5. Available online at http://www.gpo.gov/fdsys/pkg/PLAW-111publ5/pdf/PLAW-111publ5.pdf.

Clean Air Act (CAA). 42 U.S.C. § 7401 et seq. Available online at http://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/pdf/USCODE-2011-title42-chap85-subchapI.pdf.

Clean Water Act (CWA)/Federal Water Pollution Control Act. 33 U.S.C. 1344 et seq. Available online at http://www.epa.gov/npdes/pubs/cwatxt.txt.

ILCS (Illinois Compiled Statutes). 2012a. *Illinois Endangered Species Protection Act*. Available online at http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=1730&ChapterID=43.

ILCS (Illinois Compiled Statutes). 2012b. *Private Sewage Disposal Licensing Act*. Available online at http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=1337&ChapterID=24.

Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, as amended. 16 U.S.C. § 1431 et seq. and 33 USC § 1401 et seq. (1988). Available online at http://www.epa.gov/lawsregs/laws/mprsa.html.

National Environmental Policy Act of 1969, as amended (NEPA). 42 U.S.C. 4321 et seq. Available online at http://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/pdf/USCODE-2011-title42-chap55.pdf.

OSHA (Occupational Health and Safety Administration). 2012a. *Standard Industrial Code 2813; Industrial Gases*. Occupational Safety and Health Administration, Washington D.C. Available online at http://www.osha.gov/pls/imis/sic_manual.display?id=600&tab=description, accessed on 8/30/12.

OSHA (Occupational Health and Safety Administration). 2012b. *Standard Industrial Code 4619; Pipelines, Not Elsewhere Included*. Occupational Safety and Health Administration, Washington D.C. Available online at http://www.osha.gov/pls/imis/sic_manual.display?id=929&tab=description, accessed on 8/30/12.

Resource Conservation and Recovery Act of (RCRA). 42 U.S.C. § 6901 et seq. Available online at http://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/pdf/USCODE-2011-title42-chap82-subchapI.pdf.

Safe Drinking Water Act of 1974, as amended. 42 U.S.C. 300f et seq. Available online at http://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/pdf/USCODE-2011-title42-chap6A-subchapXII.pdf.

2. Chapter 2 References

40 CFR 144. Code of Federal Regulations, Title 40, *Protection of the Environment*, Part 144 "Underground Injection Control Program," Section 31, "Application for a Permit; Authorization by Permit." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.6.

40 CFR 146. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 146, "Underground Injection Control Program: Criteria and Standards." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.8.

Bell AH. 1927. *Recent Developments in the Vicinity of Jacksonville*. Illinois Petroleum Report 11, Illinois State Geologic Survey, Urbana, Illinois. Copyrighted material, available through http://library.isgs.uiuc.edu/Pubs/pdfs/illinoispetroleum/IP011.pdf.

Bergstrom RE and AJ Zeizel. 1957. *Groundwater Geology in Western Illinois, South Part*. Circular 232, Illinois State Geological Survey, Urbana, Illinois. Copyrighted material, not available electronically.

Bethke CM and S Marshak. 1990. Brine Migrations across North America − The Plate Tectonics of Groundwater. *Annual Review Earth and Planetary Sciences*, 18, 287–315. (Reprinted in WE Dietrich and G Sposito, eds., (1997) *Hydrologic Processes from Catchment to Continental Scales*, Annual Reviews, Inc.

Copyrighted material, available online through
http://www.annualreviews.org/doi/abs/10.1146/annurev.ea.18.050190.001443.

Bickford ME, WR Van Schmus, and I Zietz. 1986. "Proterozoic History of the Midcontinent Region of North America." *Geology* 14(6):492–496. Copyrighted material, available online through http://geology.gsapubs.org/content/14/6/492.

Birkholzer JT, Q Zhou, J Rutqvist, P Jordan, K Zhang, and CF Tsang. 2007. *Research Project on CO_2 Geological Storage and Groundwater Resources: Large-Scale Hydrogeological Evaluation and Impact on Groundwater Systems, Annual Report: October 1, 2006 to September 30, 2007.* LBNL-63544, Lawrence Berkeley National Laboratory, Berkeley, California.

Birkholzer JT, Q Zhou, K Zhang, P Jordan, J Rutqvist, and CF Tsang. 2008. *Research Project on CO_2 Geological Storage and Groundwater Resources: Large-Scale Hydrological Evaluation and Modeling of the Impact on Groundwater Systems Annual Report: October 1, 2007, to September 30, 2008*. Lawrence Berkeley National Laboratory, Berkeley, California.

Bowen BB, R Ochoa, ND Wilkens, J Brophy, TR Lovell, N Fischietto, C Medina, and J Rupp. 2011. "Depositional and Diagenetic Variability Within the Cambrian Mount Simon Sandstone: Implications for Carbon Dioxide Sequestration." *Environmental Geosciences* 18:69-89. Copyrighted material can be viewed online at http://www.iub.edu/~petro/publications/mtsimon.pdf.

Buschbach TC and DC Bond. 1974. *Underground Storage of Natural Gas in Illinois – 1973*. Illinois Petroleum 101, Illinois State Geological Survey, Champaign, Illinois. Copyrighted material can be viewed online at http://library.isgs.uiuc.edu/pubs/pdfs/illinoispetroleum/IP101.pdf.

Buschbach TC and DR Kolata. 1991. "Regional Setting of Illinois Basin." *In* Leighton MW, Kolata DR, Oltz DF, and Eidel JJ (eds.), *Interior Cratonic Basins*. *American Association of Petroleum Geologists Memoir* 51:29–55. Copyrighted material, available online through http://search.datapages.com/data/open/offer.do?target=%2Fspecpubs%2Fbasinar3%2Fdata%2Fa134%2Fa134%2F0001%2F0000%2F0029.htm.

Daniels DL, RP Kucks, and PL Hill. 2008. Illinois, Indiana, and Ohio Magnetic and Gravity Maps and Data: A Website for Distribution of Data. U.S. Geological Survey Data Series 321. Available online at http://pubs.usgs.gov/ds/321/.

Dey, WS, RA Locke, IG Krapac, CG Patterson, and JL Hurry. *Preliminary Hydrogeologic Investigation of the FutureGen 2 Site in Morgan County, Illinois*. Open File Series 2012-6. Prepared by the Illinois State Geological Survey for Pacific Northwest National Laboratory, Richland, Washington.

Driese SG, CW Byers, and RH Dott. 1981. "Tidal Deposition in the Basal Upper Cambrian Mount Simon Formation in Wisconsin." *Journal of Sedimentary Research*, 51:367-381. Copyrighted material, available through http://jsedres.sepmonline.org/content/51/2/367.short.

EPA (U.S. Environmental Protection Agency). 2011. *Underground Injection Control Permit Application IL-ICCS Project*. Submitted to U.S. Environmental Protection Agency Region 5 by Archer Daniels Midland Company, Decatur, Illinois. Available online at http://www.epa.gov/r5water/uic/adm/index.htm.

EPA (U.S. Environmental Protection Agency). 1994. *Determination of Maximum Injection Pressure for Class I Wells, EPA Region 5 – Underground Injection Control Section Regional Guidance #7*. Chicago, Illinois. Last accessed on 8/30/12 at http://www.epa.gov/r5water/uic/r5guid/r5_07.htm.

Freiburg T and HE Leetaru. 2012. "Controls on Porosity Development and the Potential for CO_2 Sequestration or Waste Water Disposal in the Cambrian Potosi Dolomite (Knox Group): Illinois Basin" (abstract) *AAPG Search and Discovery Article #90154.* AAPG 41st Annual Eastern Section Meeting, September 22-26, 2012, Cleveland, Ohio. Copyrighted material can be viewed online at http://www.searchanddiscovery.com/abstracts/html/2012/90154eastern/abstracts/freib.htm.

Gibb JP and M O'Hearn. 1980. *Illinois Ground Water Quality Data Summary*. Contract Report 230, Illinois State Water Survey, Urbana, Illinois.

Goetz LK, JG Tyler, RL Macarevich, D Brewster, and JR Sonnad. 1992. "Deep gas play probed along Rough Creek graben in Kentucky part of Illinois Basin." *Oil and Gas Journal* 90:97-101. Copyrighted material, available through http://www.ogj.com/articles/print/volume-90/issue-38/in-this-issue/exploration/deep-gas-play-probed-along-rough-creek-graben-in-kentucky-part-of-southern-illinois-basin.html.

Gupta N and ES Bair. 1997. "Variable-Density Flow in the Midcontinent Basins and Arches Region of the United States." *Water Resources Research* 33:1785–1802. Copyrighted material, copy provided courtesy of the lead author. Also available through http://www.agu.org/pubs/crossref/1997/97WR01199.shtml.

Hanson GF. 1960. *Summary Statement of Facilities for Underground Storage of Liquid Petroleum Products in Wisconsin*. University of Wisconsin, Wisconsin Geological and Natural History Survey, Open-File Report 1960-1, Madison, Wisconsin. Copyrighted material can be viewed online at http://wisconsingeologicalsurvey.org/wofrs/WOFR1960-01.pdf.

Hatch JR and RH Affolter. 2008. "Geologic Overview." *In* Hatch JR and RH Affolter (eds.) Chapter C of *Resource Assessment of the Springfield, Herrin, Danville, and Baker Coals of the Illinois Basin*. U.S. Geological Survey Professional Paper 1625-D, Government Printing Office, Washington D.C.

Helmotz Centre Potsdam – GFZ. 2012 *World Stress Map Project*. Available online at http://dc-app3-14.gfz-potsdam.de/. Last accessed on 5/9/2012.

Houseknecht DW. 2001. "Earliest Paleozoic stratigraphy and facies, Reelfoot Basin and adjacent craton." Pp. 27–44, in Gregg, JM, JR Palmer, and VE Krutz (eds.), *Field Guide to the Upper Cambrian of Southeastern Missouri: Stratigraphy, Sedimentology, and Economic Geology*. OFR-01-98-GS, Missouri Department of Natural Resources Open-file Report, Rolla, Missouri. Available through http://www.missourigeologystore.com/product.php?productid=224.

Hunt LI. 2004. *A Petrophysical and Shallow Geophysical Study to Determine Pathways of Gas Migration Within and Above an Underground Gas Storage Field in North-Central Illinois*. Master of Science thesis, Illinois State University, Normal, Illinois. Copyrighted material, available online at . http://lilt.ilstu.edu/ewpeter/theses/Hunt_Thesis_2004.pdf.

IDNR (Iowa Department of Natural Resources). 2012. Iowa Geological and Water Survey GeoSam Database website. Available online at http://www.igsb.uiowa.edu/webapps/geosam/.

ISGS (Illinois State Geological Survey). 2012a. Coal Mines, Coal Geology, and Resource Data Online, County Coal Map and Data Series, Morgan County. Last accessed January 4, 2012 at http://www.isgs.uiuc.edu/maps-data-pub/coal-maps/counties/morgan.shtml.

ISGS (Illinois State Geological Survey). 2012b. Illinois Natural Resources Geospatial Data Clearinghouse, Glacial Drift Thickness and Character map revised in 1998. Copyrighted material, available online at http://www.isgs.uiuc.edu/nsdihome/webdocs/st-geolq.html.

ISGS (Illinois State Geological Survey). 2012c. ILWATER Interactive Mapping Web Interface. Last accessed on January 4, 2012 at http://www.isgs.illinois.edu/maps-data-pub/wwdb/launchims.shtml.

ISGS (Illinois State Geological Survey). 2012d. Surficial Geology and Features Quaternary Deposits Map website. Last accessed on February 14, 2012 at http://www.isgs.uiuc.edu/sections/quat/deposit-map.shtml.

ISGS (Illinois State Geological Survey). 2011. Illinois Oil and Gas Resources (ILOIL) Internet Map Service. Last accessed on October 8, 2011 at http://moulin.isgs.uiuc.edu/ILOIL/webapp/ILOIL.html.

Kisvarsanyi EB. 1979. *Geologic Map of the Precambrian of Missouri.* Contributions to Precambrian Geology No 7, 1:1000000 map. Missouri Department of Natural Resources, Jefferson City, Missouri. Available through http://www.missourigeologystore.com/product.php?productid=968&cat=41&page=1.

Kolata DR. 2005. *Bedrock Geology of Illinois*. Illinois Map 14 1:500,000, Illinois State Geological Survey, Urbana, Illinois. Copyrighted material, available through http://www.isgs.uiuc.edu/nsdihome/webdocs/st-geolb.html.

Kolata DR and J Nelson. 1991. "Tectonic History of the Illinois Basin." in *Interior Cratonic Basins*, eds. MW Leighton, DR Kolata, DF Oltz, and JJ Eidel. American Association of Petroleum Geologists Memoir 51, pp. 263−285,Tulsa, Oklahoma. Copyrighted material, available through http://bookstore.aapg.org/

Kolata DR and CK Nimz. 2010. *Geology of Illinois*. Illinois State Geologic Survey, Urbana, Illinois. Copyrighted material can be viewed at http://www.isgs.illinois.edu/maps-data-pub/publications/goi/contents.shtml.

Leetaru HE and JH McBride. 2009. "Reservoir Uncertainty, Precambrian Topography, and Carbon Sequestration in the Mt. Simon Sandstone, Illinois Basin." *Environmental Geosciences* 16(4):235-243. Copyrighted material, available through http://eg.geoscienceworld.org/content/16/4/235.abstract.

Leetaru HE, SM Frailey, D Morse, RJ Finley, JA Rupp, JA Drahozval, and JH McBride. 2009. "Carbon sequestration in the Mount Simon Sandstone saline reservoir." *In* Grobe M, JC Pashin, and RL Dodge (eds.), Carbon dioxide sequestration in geological media—State of the science, *AAPG Studies in Geology* 59:261-277. Copyrighted material, available through http://members.aapg.org/scriptcontent/BeWeb/Orders/ProductDetail.cfm?pc=739.

Leetaru HE, DG Morse, R Bauer, SM Frailey, D Keefer, DR Kolata, C Korose, E Mehnert, S Rittenhouse, J Drahovzal, S Fisher, JH McBride. 2005. "Saline reservoirs as a sequestration target." In *An Assessment of Geological Carbon Sequestration Options in the Illinois Basin*, Final Report for U.S. DOE Contract: DE-FC26-03NT41994, Principal Investigator: Robert Finley. Midwest Geological Sequestration Consortium, Champaign, Illinois.

Lidiak EG. 1996. "Geochemistry of Subsurface Proterozoic Rocks in the Eastern Midcontinent of the United States: Further Evidence for a Within-Plate Tectonic Setting." in *Basement and Basins of Eastern North America,* eds. BA van der Pluijm and PA Catacosinos. Geological Society of America Special Paper 308, pp. 45-66, Boulder, Colorado. Copyrighted material, available through http://specialpapers.gsapubs.org/content/308.

Lloyd OB and WL Lyke. 1995. *Ground Water Atlas of the United States*, *Segment 10*. United States Geological Survey, U.S. Government Printing Office, Washington D.C. Can be viewed online at http://pubs.usgs.gov/ha/ha730/ch_k/K-text.html.

McBride JH and DR Kolata. 1999. "Upper Crust Beneath Central Illinois Basin, United States". *GSA Bulletin* 111(3)375-394. Copyrighted material, available online through http://bulletin.geoscienceworld.org/content/111/3/375.abstract.

MDNR (Missouri Department of Natural Resources). 2012. Missouri Department of Natural Resources Water Resources Center, Geologic Well Logs of Missouri website. Available online at http://www.dnr.mo.gov/env/wrc/logmain/index.html.

Meents WF. 1981. *Analysis of Natural Gas in Illinois, Gas, Natural – Illinois*. Illinois State Geological Survey, Urbana, Illinois. Copyrighted material can be viewed online at http://library.isgs.uiuc.edu/Pubs/pdfs/illinoispetroleum/IP122.pdf.

Morse DG and HE Leetaru. 2005. *Reservoir Characterization and Three-Dimensional Models of Mt. Simon Gas Storage Fields in the Illinois Basin*. Circular 567, Illinois State Geological Survey, Urbana, Illinois (CD-ROM). Copyrighted material, available at http://library.isgs.uiuc.edu/Pubs/pdfs/circulars/c567.pdf.

Nelson WJ. 1995. *Structural Features in Illinois*. Bulletin 100, Illinois State Geological Survey, Champaign, Illinois. Copyrighted material can be viewed online at http://library.isgs.uiuc.edu/Pubs/pdfs/bulletins/bul100.pdf.

Saller, AH, J Schwab, S Walden,S Robertson, R Nims, H Hagiwara, and S Mizohata. 2004. "Three-dimensional seismic imaging and reservoir modeling of an upper Paleozoic "reefal" buildup, Reinecke

Field, west Texas, United States." Pp. 107-125 *in* GP Eberli, JL Masaferro, and JF Sarg (eds.), *Seismic Imaging of Carbonate Reservoirs and Systems*, Volume 81, American Association of Petroleum Geologists, Tulsa, Oklahoma. Copyrighted material, available through http://bookstore.aapg.org/.

Sargent ML and Z Lasemi. 1993. "Tidally Dominated Depositional Environment for the Mount Simon Sandstone in Central Illinois." *Great Lakes Section, Geological Society of America, Abstracts and Programs* 25(3):78.

Selkregg LF and JP Kempton. 1958. *Groundwater Geology in East-Central Illinois.* Circular 248, Illinois State Geological Survey, Urbana, Illinois. Copyrighted material can be viewed online at https://www.ideals.illinois.edu/handle/2142/42718

Sminchak J. 2011. *Conceptual Model Summary Report Simulation Framework For Regional Geologic CO2 Storage Along Arches Province Of Midwestern United States*, *Topical Report*. Battelle Memorial Institute, Columbus, Ohio. Providing copy courtesy of the lead author.

Spane FA and RB Mercer. 1985. *HEADCO: A Program for Converting Observed Water Levels and Pressure Measurements to Formation Pressure and Standard Hydraulic Head*. RHO-BW-ST-71P, Rockwell Hanford Operations, Richland, Washington.

Streit JE and RR Hillis. 2004. "Estimating Fault Stability and Sustainable Fluid Pressures for Underground Storage of CO_2 in Porous Rock." *Energy* 29(9-10):1445-1456. Copyrighted material can be viewed online at http://www.asprg.adelaide.edu.au/asm/papers/streit2004.pdf.

USGS (U.S. Geological Survey). 2012a. Illinois Earthquake History website. Available at http://earthquake.usgs.gov/earthquakes/states/illinois/history.php. Last accessed on August 14, 2012.

USGS (U.S. Geological Survey). 2012b. Earthquake Search website. Available at http://earthquake.usgs.gov/earthquakes/eqarchives/epic/epic_circ.php. Last accessed on August, 14, 2012.

USGS (U.S Geological Survey). 2008. National Seismic Hazard Mapping Project, Earthquake Hazards Program. Last accessed on September 24, 2012 at http://earthquake.usgs.gov/hazards/.

Weiss, WW, X Xie, and JW Weiss. 2009. "Field Test of Wettabililty Alteration to Increase the Flow Rate from Aquifer Gas Storage Wells". Paper 125867, SPE Eastern Regional Meeting, September 23-25, 2009, Charleston, West Virginia. Copyrighted material, available through http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-125867-MS).

Whiting LL and DL Stevenson. 1965. *The Sangamon Arch*. Circular 383, Illinois State Geological Survey, Urbana, Illinois. Copyrighted material can be viewed at http://library.isgs.uiuc.edu/Pubs/pdfs/circulars/c383.pdf.

Wilkens ND, N Fischietto, BB Bowen, and J Rupp. 2011. "Anatomy of a Cambrian Sheet Sand: Depositional Environments in the Mount Simon Sandstone." *GSA Abstracts with Programs* 42(5),

Geological Society of America, Boulder, Colorado. Copyrighted material can be viewed online at https://gsa.confex.com/gsa/2010AM/finalprogram/abstract_180258.htm.

Willman HB, E Atherton, TC Buschbach, C Collinson, JC Frey, ME Hopkins, JA Lineback, and JA Simon. 1975. *Handbook of Illinois Stratigraphy*. Bulletin 95, Illinois State Geological Survey, Urbana, Illinois. Copyrighted material, available online at http://library.isgs.uiuc.edu/Pubs/pdfs/bulletins/bul095.pdf.

Woller DM and EW Sanderson. 1979. *Public Groundwater Supplies in Morgan and Scott Counties*. Bulletin 60-27, Illinois State Water Survey, Illinois Institute of Natural Resources, Urbana, Illinois. Copyrighted material can be viewed online at http://www.isws.illinois.edu/pubdoc/B/ISWSB-60-27.pdf

Young HL. 1992. *Hydrogeology of the Cambrian-Ordovician Aquifer System in the Northern Midwest, United States with a Section on Ground-water Quality*. Professional Paper 1405-B, U.S. Geological Survey, U.S. Government Printing Office, Washington D.C.

Zhou Q, JT Birkholzer, E Mehnert, Y-F Lin, and K Zhang. 2010. "Modeling basin- and plume-scale processes of CO_2 storage for full-scale deployment." *Ground Water* 48(4):494-514. Copyrighted material, available through http://onlinelibrary.wiley.com/doi/10.1111/j.1745-6584.2009.00657.x/full.

Zoback MD, CA Barton, M Brudy, DA Castillo, T Finkbeiner, BR Grollimund, DB Moos, P Peska, CD Ward, and DJ Wiprut. 2003. "Determination of Stress Orientation and Magnitude in Deep Wells." *International Journal of Rock Mechanics and Mining Sciences,* 40(7–8): 1049-1076. Copyrighted material, available through http://www.sciencedirect.com/science/article/pii/S1365160903001175.

Zoback MD. 2007. *Reservoir Geomechanics*, Cambridge University Press, Cambridge, England. Copyrghted material, available through http://www.cambridge.org/gb/knowledge/isbn/item1165898/?site_locale=en_GB.

3. Chapter 3 References

40 CFR 146. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 146, "Underground Injection Control Program: Criteria and Standards." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.8.

75 FR 77230. December 10, 2010. "Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells." *Federal Register*. Environmental Protection Agency. Available online at www.gpo.gov/fdsys/pkg/FR-2010-12-10/pdf/2010-29954.pdf.

Akaike H. 1974. "A New Look at Statistical-Model Identification." *IEEE Automat. Contr*., Ac19(6):716-723. Copyrighted material, available through http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1100705.

Birkholzer JT, Q Zhou, K Zhang, P Jordan, J Rutqvist, and CF Tsang. 2008. *Research Project on CO_2 Geological Storage and Groundwater Resources: Large-Scale Hydrological Evaluation and Modeling of the Impact on Groundwater Systems Annual Report: October 1, 2007, to September 30, 200*8. Lawrence Berkeley National Laboratory, Berkeley, California.

Buschbach TC and DC Bond. 1974. *Underground Storage of Natural Gas in Illinois – 1973*. Illinois Petroleum 101, Illinois State Geological Survey, Champaign, Illinois. Copyrighted material can be viewed online at http://library.isgs.uiuc.edu/pubs/pdfs/illinoispetroleum/IP101.pdf.

Davies, PB. 1991. *Evaluation of the Role of Threshold Pressure in Controlling Flow of Waste-Generated Gas into Bedded Salt at the Waste Isolation Pilot Plant (WIPP)*. SAND 90-3246, Sandia National Laboratory, Albuquerque, New Mexico.

EPA (U.S. Environmental Protection Agency). 2011a. *Draft Underground Injection Control (UIC) Program Class VI Well Area of Review Evaluation and Corrective Action Guidance for Owners and Operators*. EPA 816-D-10-007, Washington, D.C. Last accessed on 5/9/11 at http://water.epa.gov/type/groundwater/uic/class6/upload/GS_AoR_CA_Guidance_DRAFT_FINAL_031611.pdf.

EPA (U.S. Environmental Protection Agency). 2011b. *Underground Injection Control Permit Application IL-ICCS Project*. Submitted to U.S. Environmental Protection Agency Region 5 by Archer Daniels Midland Company, Decatur, Illinois. Available online at http://www.epa.gov/r5water/uic/adm/index.htm.

EPA (U.S. Environmental Protection Agency). 2011c. *Underground Injection Control Permit Application for the Taylorville Energy Center.* Submitted to U.S. Environmental Protection Agency Region 5 by Christian County Generation, LLC., Omaha, Nebraska. Available online at http://www.epa.gov/r5water/uic/tec/index.htm.

EPA (U.S. Environmental Protection Agency). 1994. *Determination of Maximum Injection Pressure for Class I Wells, EPA Region 5 – Underground Injection Control Section Regional Guidance #7*. Chicago, Illinois. Last accessed on 8/30/12 at http://www.epa.gov/r5water/uic/r5guid/r5_07.htm.

Haimson, B. C. and F. H. Cornet. 2003. "ISRM Suggested Methods for Rock Stress Estimation—Part 3: Hydraulic Fracturing (HF) and/or Hydraulic Testing of Pre-Existing Fractures (HTPF)." *International Journal of Rock Mechanics and Mining Sciences* 40(7–8): 1011-1020. Copyrighted material can be viewed at http://www.personal.psu.edu/szw138/Rock%20Mechanics%20Lab/Other%20ASTM/Part%203%20hydraulic%20fracturing%20(HF)%20and%20or%20hydraulic%20testing%20of%20pre-existing%20fractures%20(HTPF).pdf or available through http://www.sciencedirect.com/science/article/pii/S1365160903001254.

Hornung, J and T Aigner. 1999. "Reservoir and aquifer characterization of fluvial architectural elements: Stubensandstein, Upper Triassic, southwest Germany." *Sedimentary Geology*, 129(3-4): 215–280.

Copyrighted material, available online through
http://www.sciencedirect.com/science/article/pii/S0037073899001037.

Hou Z, ML Rockhold, and CJ Murray. 2012. "Evaluating the impact of caprock and reservoir properties on potential risk of CO_2 leakage after injection." *Environmental Earth Sciences*. 66(8):2403-2415, doi:10.1007/s12665-011-1465-2. Copyrighted material, available through http://link.springer.com/journal/12665/66/8/page/2.

Hubbert, MK and DG Willis. 1957. "Mechanics of hydraulic fracturing." *Petroleum Transactions,* AIME, 210:153-168. Copyrighted material, available online through http://www.onepetro.org/mslib/app/Preview.do?paperNumber=SPE-000686-G&societyCode=SPE.

ISGS (Illinois State Geological Survey). 2012a. ILWATER Interactive Mapping Web Interface. Last accessed on January 4, 2012 at http://www.isgs.illinois.edu/maps-data-pub/wwdb/launchims.shtml.

ISGS (Illinois State Geological Survey). 2012b. Geologic Records Unit (GRU) Website. Last accessed on February 16, 2012 at http://www.isgs.uiuc.edu/sections/gru/gru-home.shtml.

ISGS (Illinois State Geological Survey). 2011. Illinois Oil and Gas Resources (ILOIL) Internet Map Service. Last accessed on October 8, 2011 at http://moulin.isgs.uiuc.edu/ILOIL/webapp/ILOIL.html.

Kerr, DR, LS Ye, A Bahar, BM Kelkar, and SL Montgomery. 1999. "Glenn Pool Field, Oklahoma: A Case of Improved Production from a Mature Reservoir." *American Association of Petroleum Geologists Bulletin* 83(1):1-18. Copyrighted material, available online through http://aapgbull.geoscienceworld.org/content/83/1/1.abstract.

Meyer RO and FF Krause. 2006. "Permeability Anisotropy and Heterogeneity of a Sandstone Reservoir Analogue: An Estuarine to Shoreface Depositional System in the Virgelle Member, Milk River Formation, Writing-On-Stone Provincial Park, Southern Alberta." *Bulletin of Canadian Petroleum Geology* 54: 301-318. Copyrighted material, available through http://bcpg.geoscienceworld.org/content/54/4/301.abstract or can be viewed online at http://pec.ucalgary.ca/meyer/files/meyer/Meyer-Krause_aniso-hetero-k_BGSPG-2006.pdf.

Pruess, K., J Garcia, T Kovscek, C Oldenburg, J Rutqvist, C Steefel, and T Xu. 2002. *Intercomparison of Numerical Simulation Codes for Geologic Disposal of CO2*. LBNL-51813, Lawrence Berkeley National Laboratory, Berkeley, California.

Ringrose, P, K Nordahl, and RJ Wen. 2005. "Vertical permeability estimation in heterolithic tidal deltaic sandstones." *Petroleum Geoscience*, 11(1):17-28. Copyrighted material, can be viewed online at http://geomodeling.ca.66-18-244-250.previewme3.net/wp-content/Docs/SBED_PermeabilityHeterolithicTidalDeltaicSandstones_2004.pdf or available through http://pg.eage.org/publication/allissues?p=4 .

Saller AH, J Schwab, S Walden, S Robertson, R Nims, H Hagiwara, and S Mizohata. 2004. "Three-dimensional seismic imaging and reservoir modeling of an upper Paleozoic "reefal" buildup, Reinecke

Field, west Texas, United States." Pp. 107-125 *in* GP Eberli, JL Masaferro, and JF Sarg (eds.), *Seismic Imaging of Carbonate Reservoirs and Systems*, Volume 81, American Association of Petroleum Geologists, Tulsa, Oklahoma. Copyrighted material, available through http://bookstore.aapg.org/.

Span R and W Wagner. 1996. "A New Equation of State for Carbon Dioxide Covering the Fluid Region from the Triple-Point Temperature to 1100 K at Pressures Up to 800 MPa." J Phys Chem Ref Data 25:1509-1596. Available online at http://www.nist.gov/data/PDFfiles/jpcrd516.pdf.

Spycher, N. and K. Pruess. 2010. "A Phase-Partitioning Model for CO2-Brine Mixtures at Elevated

Temperatures and Pressures: Application to CO2-Enhanced Geothermal Systems." *Transport in Porous*

Media, 82:173-196, doi:10.1007/s11242-009-9425-y. Copyrighted material, can be viewed online at http://escholarship.org/uc/item/0kp5q3vn#page-1.

Spycher, N., K. Pruess, and J. Ennis-King. 2003. "CO_2-H_2O mixtures in geological sequestration of CO_2. I. Assessment and calculation of mutual solubilities from 12 to 100°C and up to 600 bar." *Geochimica et Cosmoschimica Acta*, 67(16):3015-3031, doi:10.1016/s0016-7037(03)00273-4. Copyrighted material, available through http://www.sciencedirect.com/science/article/pii/S0016703703002734 or can be viewed online at http://144.206.159.178/FT/402/184084/4703918.pdf

Suekane T, NH Thanh, T Matsumoto, M Matsuda, M Kiyota, and A Ousaka. 2009. "Direct measurement of trapped gas bubbles by capillarity on the pore scale." *Energy Procedia* 1(1):3189-3196, doi:10.1016/j.egypro.2009.02.102. 600 bar." *Geochimica et Cosmoschimica Acta*, 67(16):3015-3031, doi:10.1016/s0016-7037(03)00273-4. Copyrighted material, available through

http://www.sciencedirect.com/science/article/pii/S1876610209007450.

Venables WN and BD Ripley. 2002. *Modern applied statistics with S.* Springer Science+Business Media, NewYork, New York. Copyrighted material available through http://www.springer.com/statistics/computational+statistics/book/978-0-387-95457-8.

White MD, DH Bacon, BP McGrail, DJ Watson, SK White, and ZF Zhang. 2012. *STOMP Subsurface Transport Over Multiple Phases: STOMP-CO2 and STOMP-CO2e Guide: Version 1.0* . PNNL-21268, Pacific Northwest National Laboratory, Richland, Washington.

White MD and M Oostrom. 2006. *STOMP Subsurface Transport Over Multiple Phases, Version 4: User's Guide.* PNNL-15782, Pacific Northwest National Laboratory, Richland, Washington.

White MD and M Oostrom. 2000. *STOMP Subsurface Transport Over Multiple Phases: Theory Guide*. PNNL-12030, Pacific Northwest National Laboratory, Richland, Washington.

White SK, ZF Zhang, TJ Gilmore, PD Thorne, and MD White. 2011. "Quantifying the Predicted Extent of the CO_2 plume for Delineating the Area of Review." Presented by Fred Zhang at American Geophysical Union's 2011 Fall Meeting, San Francisco, CA on December 7, 2011. PNWD-SA-9683, Pacific Northwest National Laboratory, Richland, Washington. Not publicly available, copy provided courtesy of author.

Zhou Q, JT Birkholzer, E Mehnert, Y-F Lin, and K Zhang. 2010. "Modeling basin- and plume-scale processes of CO_2 storage for full-scale deployment." *Ground Water* 48(4):494-514. Copyrighted material, available online through http://onlinelibrary.wiley.com/doi/10.1111/j.1745-6584.2009.00657.x/full.

Zoback MD, CA Barton, M Brudy, DA Castillo, T Finkbeiner, BR Grollimund, DB Moos, P Peska, CD Ward, and DJ Wiprut. 2003. "Determination of Stress Orientation and Magnitude in Deep Wells." *International Journal of Rock Mechanics and Mining Sciences,* 40(7–8): 1049-1076. Copyrighted material, available online through http://www.sciencedirect.com/science/article/pii/S1365160903001175.

4. Chapter 4 References

40 CFR 146. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 146, "Underground Injection Control Program: Criteria and Standards." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.8.

75 FR 77230. December 10, 2010. "Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells." *Federal Register*. Environmental Protection Agency. Available online at www.gpo.gov/fdsys/pkg/FR-2010-12-10/pdf/2010-29954.pdf.

American Petroleum Institute (API) (2010). Specification 6A – Specification for Wellhead and Christmas Tree Equipment. Twentieth Edition (ISO 10423:2009 Modification), Includes Errata (Jan. and Nov. 2011) and Addendum 1 (Nov. 2011) 20th Edition. Washington, D.C. Copyrighted material, available through http://www.techstreet.com/cgi-bin/detail?doc_no=api%7Cspec_6a;product_id=1744826.

EPA (U.S. Environmental Protection Agency). 2008. *Determination of the Mechanical Integrity of Injection Wells, Region 5, Underground Injection Control (UIC) Branch Regional Guidance* #5. Chicago, Illinois. Available online at http://www.epa.gov/region5/water/uic/r5guid/r5_05_2008.htm.

Gulf Interstate Engineering (GIE). 2011. *FutureGen Alliance CO2 Pipeline Feasibility Study Design Basis Memorandum (Preliminary)*. Prepared by Gulf Interstate Engineering for The FutureGen Industrial Alliance, Inc. 1101 Pennsylvania Avenue, NW Washington, DC 20004 and the U.S. Department of Energy. (DOE Award Number DE-FE0001882).

NACE (National Association of Corrosion Engineers International). 2009. *Petroleum and Natural Gas Industries—Materials for Use in H_2S-Containing Environments in Oil and Gas Production*. ANSI/NACE MR0175/ISO 15156, Houston, Texas. Copyrighted material, available online through http://www.nace.org/cstm/Store/Product.aspx?id=ffdf4379-fb8b-470b-b7e7-12f6d9f11974.

Resource Conservation and Recovery Act of (RCRA). 42 U.S.C. § 6901 et seq.

Safe Drinking Water Act of 1974, as amended. 42 U.S.C. 300f et seq. Available online at http://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/pdf/USCODE-2011-title42-chap6A-subchapXII.pdf.

Schlumberger. 2008. *Osprey Tubular Designer*. Version 2008.1, Houston, Texas. Freeware available at http://osprey-tubular-designer.software.informer.com/.

Schlumberger. 2006. *Tubular Design and Analysis System*. Version 6.1.6, Houston, Texas. Unable to provide copy at this time.

Span R and W Wagner. 1996. "A New Equation of State for Carbon Dioxide Covering the Fluid Region from the Triple-Point Temperature to 1100 K at Pressures Up to 800 MPa." J Phys Chem Ref Data 25:1509-1596. Available online at http://www.nist.gov/data/PDFfiles/jpcrd516.pdf.

5. Chapter 5 References

40 CFR 146. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 146, "Underground Injection Control Program: Criteria and Standards." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.8.

75 FR 77230. December 10, 2010. "Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells." *Federal Register*. Environmental Protection Agency. Available online at www.gpo.gov/fdsys/pkg/FR-2010-12-10/pdf/2010-29954.pdf.

American Society for Testing and Materials **(**ASTM). 2011. *Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens.* ASTM G1-03(2011), American Society for Testing and Materials, Philadelphia, Pennsylvania. Copyrighted material, available through http://www.astm.org/Standards/G1.htm.

Dietz R. N. 1986. "Perfluorocarbon tracer technology." In *Regional and Long-Range Transport of Air Pollution*; Lectures of a course held at the Joint Research Centre, Ispra, Italy, September 15-19, 1986. S Sandroni (ed.), pp. 215-247. BNL-38847, Brookhaven National Laboratory, Upton, New York. Can be viewed online at http://www.ecd.bnl.gov/pubs/BNL38847.pdf

DOE/NETL (U.S. Department of Energy National Energy Technology Laboratory). 2009. *Best Practices for: Monitoring, Verification, and Accounting of CO_2 Stored in Deep Geologic Formations*. DOE/NETL-311/081508, Pittsburgh, Pennsylvania. Can be viewed online at http://www.netl.doe.gov/technologies/carbon_seq/refshelf/MVA_Document.pdf.

Eastoe J, A Dupont, and D Steytler. 2003. "Fluorinated Surfactants in Supercritical CO_2." *Current Opinion in Colloid and Interface Science*, 8(3):267-273, Elesevier, Amsterdam, Netherlands. Copyrighted material, available through http://www.ingentaconnect.com/content/els/13590294/2003/00000008/00000003/art00053.

EPA (U.S. Environmental Protection Agency). 2011. *Draft Underground Injection Control (UIC) Program Class VI Well, Area of Review Evaluation and Corrective Action Guidance for Owners and Operators*. EPA 816-D-10-007, Washington, D.C. Last accessed on 5/9/11 at http://water.epa.gov/type/groundwater/uic/class6/upload/GS_AoR_CA_Guidance_DRAFT_FINAL_031611.pdf.

EPA (U.S. Environmental Protection Agency). 2008. *Determination of the Mechanical Integrity of Injection Wells, EPA Region 5 – Underground Injection Control (UIC) Branch, Regional Guidance #5*. Chicago, Illinois. Available online at http://www.epa.gov/r5water/uic/r5guid/r5_05_2008.htm.

EPA (U.S. Environmental Protection Agency). 2002. *EPA Region 6 UIC Pressure Falloff Testing Guideline, Third Revision*. Dallas, Texas. Available online at http://www.epa.gov/region6/water/swp/uic/guideline.pdf.

EPA (U.S. Environmental Protection Agency). 1998. *Planning, Executing, and Reporting Pressure Transient Tests, EPA Region 5 – Underground Injection Control Section, DRAFT Regional Guidance #6 Revised June 3, 1998.* Chicago, Illinois. Available online at http://www.epa.gov/r5water/uic/r5guid/r5_06dr.htm.

Flury M and N Wai. 2003. "Dyes as Tracers for Vadose Zone Hydrology." *Reviews of Geophysics* 41(1) doi:10.1029/2001RG000109. Copyrighted material, available through http://www.agu.org/pubs/crossref/2003/2001RG000109.shtml or can be viewed online at http://akasha.wsu.edu/~flury/theses_articles/dyereview.pdf.

Freifeld B, RC Trautz, YK Kharaka, TJ Phelps, LR Myer, SD Hovorka, and DJ Collins. 2005. "The U Tube: A Novel System for Acquiring Borehole Fluid Samples from a Deep Geologic CO_2 Sequestration Experiment." *Journal of Geophysical Research Solid Earth,* 110, B10203. Copyrighted material, available through http://www.agu.org/pubs/crossref/2005/2005JB003735.shtml.

Person M, A Banerjee, J Rupp, C Medina, P Lichtner, C Gable, R Pawar, M Celia, J McIntosh, and V Bense. 2010. "Assessment of Basin-Scale Hydrologic Impacts of CO_2 Sequestration, Illinois Basin." *International Journal of Greenhouse Gas Control* 4(5):840-854. Copyrighted material, available through http://www.sciencedirect.com/science/article/pii/S1750583610000605

Rose PE, SD Johnson, and P Kilbourn. 2001. "Tracer Testing at Dixie Valley, Nevada, using 2-naphthalene sulfonate and 2,7-naphthalene disulfonate." *In* Proceedings of 26th Workshop on Geothermal Reservoir Engineering, Stanford University, January 29-31, 2001, Stanford University. Palo Alto, California. Can be viewed online at https://pangea.stanford.edu/ERE/pdf/IGAstandard/SGW/2001/Rose.pdf.

Spangler LH, LM Dobeck, K Repasky, A Nehrir, S Humphries, J Barr, C Keith, J Shaw, J Rouseb, A Cunningham, S Benson, CM Oldenburg, JL Lewicki, A Wells, R Diehl, B Strazisar, J Fessenden, T Rahn, J Amonette, J Barr, W Pickles, J Jacobson, E Silver, E Male, H Rauch, K Gullickson, R Trautz, Y Kharaka, J Birkholzer, and L Wielopolski. 2009. "A Controlled Field Pilot for Testing Near Surface CO_2 Detection

Techniques and Transport Models." *Energy Procedia* 1:2143-2150. Copyrighted material, available through http://www.sciencedirect.com/science/article/pii/S187661020900280X.

Steele P, Z Loh, D Etheridge, R Leuning, P Krummel, and A Van Pelt. 2008. "Continuous Greenhouse Gas and Isotopic CO_2 Measurements Via WS-CRDS-Based Analyzers: Investigations in Real Time Monitoring at CO_2 Geological Storage Sites." Presented at American Geophysical Union, Fall Meeting 2008, abstract #U41C-0024, poster. Copyrighted material, can be viewed online at http://www.picarro.com/assets/docs/AGU_poster_sequestration.pdf.

Stetzenbach K and I Farnham. 1995. *Identification and Characterization of Conservative Organic Tracers for Use as Hydrologic Tracers for the Yucca Mountain Site Characterization Study, Progress Report*. DOE DE-FC 08-90NV10872, prepared by University of Nevada-Las Vegas for US Department of Energy. Can be viewed online at http://www.osti.gov/bridge/purl.cover.jsp?purl=/93999-u1FWA3/webviewable/93999.pdf.

Wells A, R Diehl, G Bromhal, B Strazisar, T Wilson, and C White. 2007. "The Use of Tracers to Assess Leakage from the Sequestration of CO_2 in a Depleted Oil Reservoir, New Mexico, USA." *Applied Geochemistry* 22:996-1016. Copyrighted material, available through http://www.sciencedirect.com/science/article/pii/S0883292707000145.

White MD, DH Bacon, BP McGrail, DJ Watson, SK White, and ZF Zhang. 2012. *STOMP Subsurface Transport Over Multiple Phases: STOMP-CO2 and STOMP-CO2e Guide: Version 1.0* . PNNL-21268, Pacific Northwest National Laboratory, Richland, Washington.

White MD and BP McGrail. 2005. *STOMP Subsurface Transport Over Multiple Phases, Version 1.0, Addendum: ECKEChem Equilibrium-Conservation-Kinetic Equation Chemistry and Reactive Transport.* PNNL-15482, Pacific Northwest National Laboratory, Richland, Washington.

White MD and M Oostrom. 2006. *STOMP Subsurface Transport Over Multiple Phases, Version 4: User's Guide.* PNNL-15782, Pacific Northwest National Laboratory, Richland, Washington.

6. Chapter 6 References

40 CFR 146. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 146, "Underground Injection Control Program: Criteria and Standards." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.8.

American Petroleum Institute (API). 2010. *Specification for Cements and Materials for Well Cementing*. ANSI/API Specification 10A, Twenty-fourth edition, Washington, D.C. Copyrighted material, available through http://www.techstreet.com/standards/api/spec_10a?product_id=1757666.

American Society for Testing and Materials **(**ASTM). 2010. *Standard Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements.* ASTM C465, 10th edition, Englewood, Colorado. Copyrighted material, available through http://www.astm.org/Standards/C465.htm.

7. Chapter 7 References

40 CFR 146. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 146, "Underground Injection Control Program: Criteria and Standards." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.8.

EPA (U.S. Environmental Protection Agency). 2011. *Draft Underground Injection Control (UIC) Program Class VI Well Project Plan Development Guidance for Owners and Operators*. EPA 816-D-10-012, Office of Water (4606M), Washington, D.C. Last accessed on 5/9/11.

EPA (U.S. Environmental Protection Agency). 2010. *Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells Final Rule* (40 CFR 146.93). Washington, D.C.

8. Chapter 8 References

40 CFR 146. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 146, "Underground Injection Control Program: Criteria and Standards." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.8.

EPA (U.S. Environmental Protection Agency). 2011. *Draft Underground Injection Control (UIC) Program Class VI Well Project Plan Development Guidance for Owners and Operators*. EPA 816-D-10-012, Office of Water (4606M), Washington, D.C. Available online at http://water.epa.gov/type/groundwater/uic/class6/upload/GS_Proj_Plan_Development_Guidance_DRAFT_FINAL_031111.pdf.

9. Chapter 9 References

40 CFR 146. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 146, "Underground Injection Control Program: Criteria and Standards." Available online at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=774ab822b9c130b9e2f051b076114d7a&ty=HTML&h=L&r=PART&n=40y24.0.1.1.8.

Clean Coal FutureGen for Illinois Act. Illinois Public Act 097-0618, effective October 26, 2011. Available online at http://www.ilga.gov/legislation/publicacts/97/PDF/097-0618.pdf

EPA (U.S. Environmental Protection Agency). 2011. *UIC Program Class VI Financial Responsibility Guidance*, Appendix B (Recommended Financial Responsibility Instruments). EPA 816-R-11-005, Washington, D.C. Available online at http://water.epa.gov/type/groundwater/uic/class6/upload/uicfinancialresponsibilityguidancefinal072011.pdf.

Appendix B

RAI 12-20-2013_002

Additional Information Regarding

References used in the Responses to EPA Requests for Additional Information

(RAI# 10-31-2013 & RAI# 11-14-2013)

1. Response to RAI#10-31-2013_004 References

Cornet F.H.; 1993; The HTPF and the Integrated stress determination methods; Comprehensive Rock Engineering (Hudson ed.); Vol 3, ch. 15, pp 413-432 Pergammon Press, Oxford. Copyrighted material, not available online.

Haimson B.C. and F.H. Cornet; 2003; ISRM Suggested Methods for rock stress estimation; Part III:Hydraulic fracturing methods ; Int. Jou. Rock. Mech. Min. Sc., vol. 40, 7/8, pp 1011-1020. Copyrighted material available through http://www.sciencedirect.com/science/article/pii/S1365160903001254 .

2. Response to RAI#11-14-2013_001 References

Gaus, I., P. Audigane, A. Laurent, J. Lions, N. Jacquemet, P. Durst, I. Czernichowski-Lauriol, and M. Azaroual. 2008. Geochemical and solute transport modelling for CO_2 storage, what to expect from it? *International Journal of Greenhouse Gas Control* 2:605–625. Copyrighted material available online at http://hal.inria.fr/docs/00/56/81/97/PDF/2008-Gaus-et-al-IJGGC.pdf

White, S.P., R. Allis, J. Moore, T. Chidsey, C. Morgan, W. Gwynn, and M. Adams. 2005. Simulation of reactive transport of injected CO_2 on the Colorado Plateau, Utah, USA. *Chemical Geology* 217:387–405. Copyrighted material, available through http://www.sciencedirect.com/science/article/pii/S0009254105000239.

3. Response to RAI#11-14-2013_011 and 11-14-2013_12 References

Caflisch, R.E. 1998. Monte Carlo and quasi-Monte Carlo methods. *Acta Numerica* 7:1–49. Copyrighted material available online at http://dsec.pku.edu.cn/~tieli/notes/numer_anal/MCQMC_Caflisch.pdf

Hou, Z., M. Huang, L.R. Leung, G. Lin, and D.M. Ricciuto. 2012. Sensitivity of surface flux simulations to hydrologic parameters based on an uncertainty quantification framework applied to the Community Land Model. *Journal of Geophysical Research* 117, D15108.

Wang, X.Q., and I.H. Sloan. 2008. Low discrepancy sequences in high dimensions: How well are their projections distributed? *Journal of Computational and Applied Mathematics* 213:366–386. Copyrighted material available online at http://www.maths.unsw.edu.au/sites/default/files/amr06_8_0.pdf.

4. Response to RAI#11-14-2013_014 References

Brooks, R.H., and A.T. Corey. 1964. Hydraulic properties of porous media. Colorado State University Hydrology Paper No. 3. Colorado State University, Fort Collins, Colorado. Copyrighted material available online at http://digitool.library.colostate.edu///exlibris/dtl/d3_1/apache_media/L2V4bGlicmlzL2R0bC9kM18xL2FwYWNoZV9tZWRpYS8xNTIyNTc=.pdf

Burdine, N.T. 1953. Relative permeability calculations form pore size distribution data. *Transactions of The Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers* 198:71–78. Copyrighted Material available through http://www.aimehq.org/resources/library.

5. Response to RAI#11-14-2013_015 References

Civan, F. 2010. Effective correlation of apparent gas permeability in tight porous media. *Transport in Porous Media* 82(2): 375-384. Copyrighted material available through http://link.springer.com/article/10.1007%2Fs11242-009-9432-z

Jones, S.C. 1972. A rapid accurate unsteady-state Klinkenberg permeameter. *Society of Petroleum Engineers Journal* 383-397. Copyrighted Material available through http://www.onepetro.org/mslib/servlet/onepetropreview?id=00003535

Rushing, J.A., K.E. Newsham, P.M. Lasswell, and T.A. Blasingame. 2004. Klinkenberg-corrected permeability measurements in tight gas sands: Steady-state versus unsteady-state techniques. SPE Annual Technical Conference and Exhibition, 26-29 September 2004Houston, Texas. SPE 89867. Copyrighted material available at http://www.onepetro.org/mslib/servlet/onepetropreview?id=00089867

Ziarani, A.S., and R. Aguilera. 2012. Knudsen's permeability correction for tight porous media. *Transport in Porous Media* 91:239−260. Copyrighted material available online at http://link.springer.com/content/pdf/10.1007/s11242-011-9842-6.pdf

6. Response to RAI#11-14-2013_016 References

Bandilla, K.W., M.A. Celia, T.R. Elliot, M. Person, K.M. Ellet, J.A. Rupp, C. Gable, and Y. Zhang. 2012. Modeling carbon sequestration in the Illinois Basin using a vertically-integrated approach. *Computing and Visualization in Science* 15:39-51*:*W02532. Copyrighted Material available through http://link.springer.com/article/10.1007%2Fs00791-013-0195-2#

Krevor, S.C., R. Pini, L. Zuo, and S. M. Benson. Relative permeability and trapping of CO2 and water in sandstone rocks at reservoir conditions. Water Resources Research 48(2). Copyrighted Material available through http://onlinelibrary.wiley.com/doi/10.1029/2011WR010859/abstract

Webb, S.W. 2000. A simple extension of two-phase characteristic curves to include the dry region. *Water Resources research* 36(6): 1425-1430. Copyrighted material available through http://onlinelibrary.wiley.com/doi/10.1029/2000WR900057/abstract

Zhou, Q., J.T.Birkholzer., E. Mehnert, Y.F. Lin, and K. Zhang. 2010. Modeling basin and plume-scale processes of CO_2 storage for full scale deployment. *Ground Water* 48(4): 494–514. Copyrighted material available online at http://escholarship.org/uc/item/7ng677jk#page-1

7. Response to RAI#11-14-2013_018 References

Birkholzer, J.T., J.P. Nicot, C.M. Oldenburg, Q. Zhou, D. Kraemer, and K.W. Bandilla. 2011. Brine Flow up a Borehole Caused by Pressure Perturbation from CO_2 Storage: Static and Dynamic Evaluations. *International Journal of Greenhouse Gas Control* 5(4):850−861. Copyrighted material publically available at http://escholarship.org/uc/item/0b63z3j4#page-1

Celia, M.A., J.M. Nordbotten, B. Court, M. Dobossy, and S. Bachu. 2011. Field-scale Application of a Semi-Analytical Model for Estimation of CO_2 and Brine Leakage Along Old Wells. *International Journal of Greenhouse Gas Control* 5:257–269. Copyrighted material available through http://www.sciencedirect.com/science/article/pii/S1750583610001544

Cihan A., Q. Zhou, and J-T. Birkholzer. 2011. Analytical solutions for pressure perturbation and fluid leakage through aquitards and wells in multilayered-aquifer systems. *Water Resources Research* 47. Copyrighted material available online at http://esd.lbl.gov/files/about/staff/quanlinzhou/Paper23_PDF.pdf.

Cihan A., J-T. Birkholzer, and Q. Zhou. 2013. Pressure Buildup and Brine Migration During CO_2 Storage in Multilayered Aquifers. *Groundwater* 51(2). Copyrighted material available through http://onlinelibrary.wiley.com/doi/10.1111/j.1745-6584.2012.00972.x/abstract

Crow, W., J.W. Carey, S. Gasda, B. Williams, and M.A. Celia. 2010. Wellbore integrity analysis of a natural CO_2 producer. International Journal of Greenhouse Gas Control 4:186–197. Copyrighted material available online at www.lanl.gov/source/orgs/ees/ees14/pdfs/09/CrowCarey09.pdf

Watson, T. L., and S. Bachu. 2008. Identification of Wells with High CO_2-Leakage Potential in Mature Oil Fields Developed for CO_2-Enhanced Oil Recovery. Paper SPE 11294, SPE Improved Oil Recovery Symposium, Tulsa, Oklahoma. Copyrighted material available through http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-112924-MS

8. Response to RAI#11-14-2013_019 References

Birkholzer, J.T., J.P. Nicot, C.M. Oldenburg, Q. Zhou, S. Kraemer, and K.W. Bandilla. 2011. Brine Flow up a Borehole Caused by Pressure Perturbation from CO_2 Storage: Static and Dynamic Evaluations. *International Journal of Greenhouse Gas Control* 5(4):850–861. Copyrighted material available online at http://escholarship.org/uc/item/0b63z3j4#page-1

EPA (U.S. Environmental Protection Agency). 2011. *Draft Underground Injection Control (UIC) Program Class VI Well Area of Review Evaluation and Corrective Action Guidance for Owners and Operators*. EPA 816-D-10-007, EPA Office of Water, Washington, D.C.

Appendix C

RAI 12-20-2013_003

Additional Information Regarding

Construction Procedures and Plugging and Abandonment Plans for the Monitoring Wells

Plugging and Abandonment of Monitoring Wells

The monitoring well network (Figure 1) has been updated in accordance with discussion in the UIC application supporting documentation.

> Chapter 5 UIC Supporting Documentation section 5.1, p. 5.2: The monitoring network design was developed based on the current conceptual understanding of the Morgan County CO_2 storage site and was used to guide development of the testing and monitoring approaches described in Section 5.2. The technical approaches described in Section 5.2 should be considered working versions that over time will be updated and modified as required in response to changes in the site conceptual model and/or operational parameters.

The objective of the monitoring program is to select and implement a suite of monitoring technologies that are both technically robust and cost-effective and provide an effective means of 1) evaluating CO_2 mass balance and 2) detecting any unforeseen containment loss.

The application proposed two single-level in-reservoir (SLR) wells, one above confining zone (ACZ) well, one underground source of drinking water (USDW) well, and a one multi-level in-reservoir (MLR) well within the injection reservoir for a total of five monitoring wells.

As part of the project's design optimization the monitoring well network design has been revised (Figure 2) to increase its effectiveness, simplify its engineering design, and hopefully eliminate any permitting challenges that might have been associated with the MLR. The revisions include eliminating the MLR well in favor of adding two fully cased reservoir access tube (RAT) wells. The revised design includes a total of seven monitoring wells as follows:

- Two ACZ wells. These wells will be used to monitor immediately above the Eau Claire caprock in the Ironton Sandstone. Pressure and hydrochemistry will be monitored.
- Two SLR wells, one of which is a reconfiguration of the previously drilled stratigraphic well. These wells will be used to monitor pressure and hydrochemistry within the injection zone beyond the east and west ends of the horizontal CO_2-injection laterals.
- Two RAT wells. These are fully cased wells, which allow access for monitoring instrumentation via pulsed-neutron logging equipment to quantify CO_2 saturation in the reservoir. The wells will not be perforated to avoid two-phase flow near the borehole, which can distort the CO_2 saturation measurements.
- One USDW well. This well will be used to monitor the lowermost USDW (St. Peter Sandstone).

Note that the specific geographic coordinates of each well remain "proposed" as the project is in the process of finalizing legal agreements with surface landowners. Also, we believe this proposed network should substantially exceed the intent of the regulations. Thus, we respectfully ask that only those wells required to meet the minimum permit requirements be included in the permit as prerequisite permit conditions.

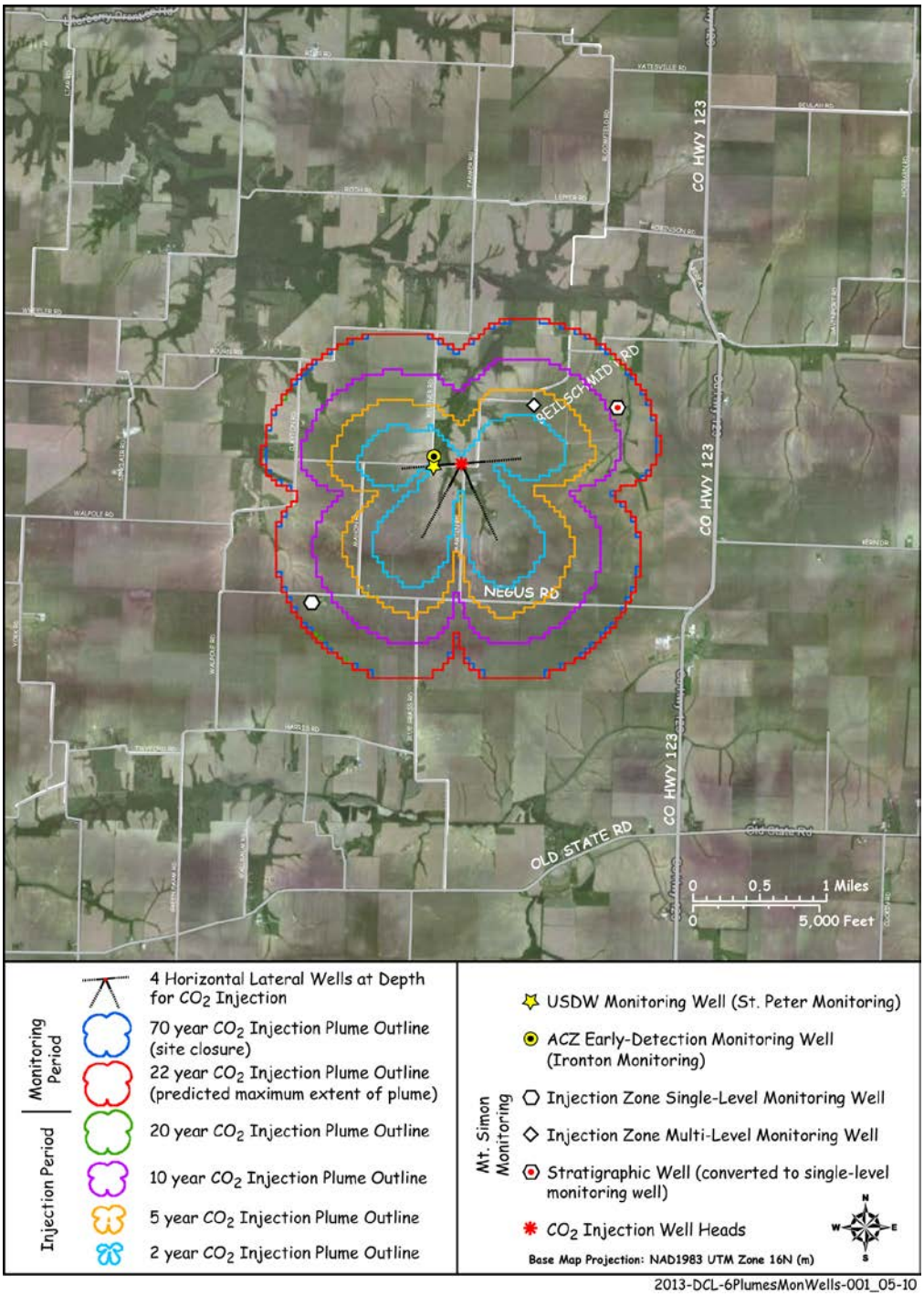


Figure 1. Monitoring Well Network as Presented in Testing and Monitoring Plan (Chapter 5) of the UIC Permit Supporting Documentation as Submitted in May 2013

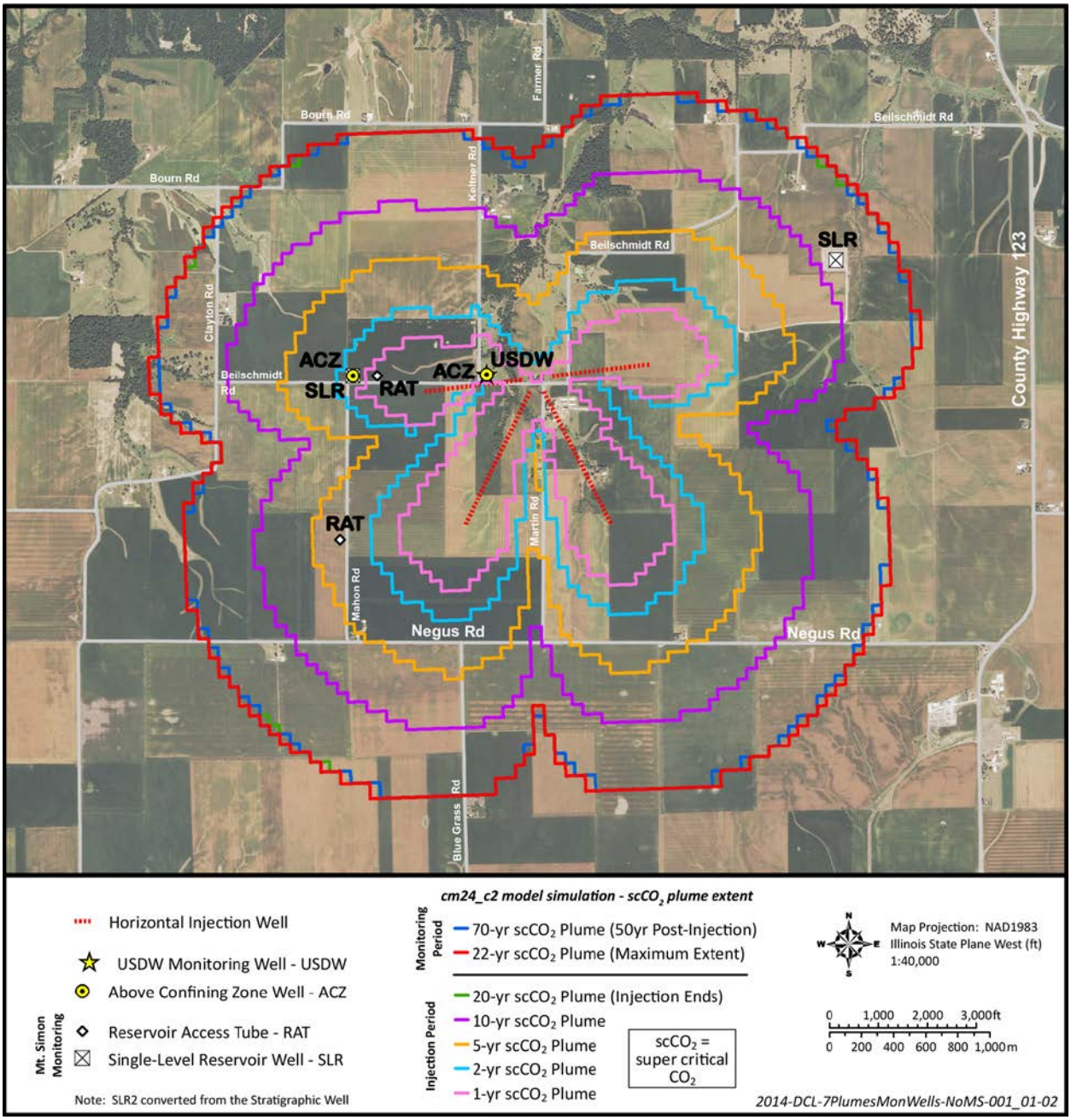


Figure 2. Updated and Revised Plan for Monitoring Wells.

Monitoring Wells Plugging

Upon site closure, all monitoring wells will be plugged and capped below grade. The most recent monitoring well design includes five deep monitoring wells and two RAT wells as listed in Table 1.

Table 1. Planned Monitoring Wells within the FutureGen Site Network

	Single-Level In-Reservoir (SLR)	Above Confining Zone (ACZ)	USDW	Reservoir Access Tube (RAT)
# of Wells	2	2	1	2
Total Depth (ft)	4,150	3,470	2,000	4,465
Monitored Zone	Mount Simon SS	Ironton SS	St. Peter SS	Mount Simon SS
Monitoring Instrumentation	Fiber-optic P/T (tubing conveyed)[b]; P/T/SpC probe in monitored interval[(a)]	Fiber optic (microseismic) cable cemented in annulus; P/T/SpC probe in monitored interval[(a)]	P/T/SpC probe in monitored interval[(a)]	Pulsed-neutron logging equipment

(a) The P/T/SpC (pressure, temperature, specific conductance) probe is an electronic downhole multiparameter probe incorporating sensors for measuring fluid P/T/SpC within the monitored interval. This probe may also be configured with sensors to measure pH and Eh. The probe is installed inside tubing string, which is perforated (slotted) over the monitoring interval. Sensor signals are multiplexed to a surface data logger through a single conductor wireline cable.
(b) Fiber-optic cable attached to the outside of the tubing string, in the annular space between the tubing and casing.
SS = sandstone.

All deep monitoring wells at the site will be plugged to prevent any upward migration of the CO_2 or formation fluids to USDWs. Each of the five deep monitoring wells and the RAT wells will be plugged and abandoned using best practices to prevent the communication of fluids between the injection zone and the USDWs. The planned well construction design for the two SLR, two ACZ and the single USDW monitoring wells are illustrated in Appendix A, as well as the planned construction design for the RAT wells.

Before the wells are plugged, the internal and external integrity of the wells will be confirmed by conducting cement-bond, temperature, and noise logs on each of the wells. In addition, a pressure fall-off test will be performed above the perforated or screened intervals (where present) to confirm well integrity. The results of the logging and testing will be reviewed and approved by appropriate regulatory agencies prior to plugging the wells.

The five monitoring wells with either casing perforations or screens will be plugged using a CO_2-resistant cement retainer method to cement the open intervals and a balanced plug method to cement the well above open intervals and cement retainer. The RAT wells, which are completely cased without an open interval, will be abandoned using the balanced-plug method. Once the interior of the casing has been properly plugged with cement, the casing will be cut off below ground and capped. Regulations at the time of the plugging and abandonment will dictate the specifications regarding the depth at which the casing is cut and the method used to cap the well.

SLR Wells Plugging and Abandonment

At the conclusion of the post-operations monitoring period (~50-year), the SLR wells will be plugged and abandoned in accordance with the well plugging plan that is incorporated into the supporting documentation of the Class VI UIC permit applications. Well-plugging activities will begin with the complete removal of in-well data transmission cables, along with fiber-optic cables attached to the 2-7/8-in stainless-steel tubing as well as the tubing packer and bridge plug (Figure A-1). With all extraneous equipment removed, the well will be flushed with a buffer fluid (if possible) and a final external mechanical-integrity test (MIT) of the well casing will be performed via pulsed-neutron capture (PNC) logging prior to backfilling the well with cement. The cement plugging material at the bottom of the well will be compatible with the CO_2 injectate to prevent cement degradation over time. For the cost estimate, it is assumed that each of the wells will be filled completely with cement from total depth (TD) to ground surface. The well casings will be cut off at ground surface and covered with a steel plate and a permanent marker that contains identifying information about the well (permit number, owner, etc.).

ACZ Well Plugging and Abandonment

At the conclusion of the post-operations monitoring period (~50-year), the ACZ wells will be plugged and abandoned in accordance with the well plugging plan that is incorporated into the supporting documentation of the Class VI UIC permit applications. First, all extraneous equipment within the well will be removed, including the in-well data-transmission cable and bridge plug. Next, the well will be flushed with a buffer fluid (if possible) and a final external MIT of the well casing will be performed via PNC logging prior to backfilling the well with cement. The cement plugging material at the bottom of the well will be compatible with any escaping CO_2 injectate. For the cost estimate, it is assumed that each of the wells will be filled completely with cement from TD to ground surface. The well casings will be cut off at ground surface and covered with a steel plate and a permanent marker that contains identifying information about the well (permit number, owner, etc.).

USDW Well Plugging and Abandonment

At the conclusion of the post-operations monitoring period (~50-year), the USDW well will be plugged and abandoned in accordance with the well plugging plan that is incorporated into the Class VI UIC permit. First, all extraneous equipment within the well will be removed, including the in-well data-transmission cable and bridge plug. Next, the well will be flushed with a buffer fluid (if possible) and a final external MIT of the well casing will be performed via PNC logging prior to backfilling the well with cement. The cement plugging material at the bottom of the well will be compatible with any escaping CO_2 injectate. For the cost estimate, it is assumed that the USDW well will be filled completely with cement from TD to ground surface. The well casings will be cut off at ground surface and covered with a steel plate and a permanent marker that contains identifying information about the well (permit number, owner, etc.).

RAT Well Plugging and Abandonment

At the conclusion of the post-operations monitoring period (~50-year), the RAT wells will be plugged and abandoned by flushing the holes with a buffer fluid (if possible) and a final external MIT of the well casing will be performed via PNC logging prior to backfilling the holes with cement. The cement plugging material at the bottom of the hole will be compatible with CO_2 injectate to prevent cement degradation over time. For the cost estimate, it is assumed that the RAT wells will be filled completely with cement from TD to ground surface. The well casings will be cut off at ground surface and covered

with a steel plate and a permanent marker that contains identifying information about the well (permit number, owner, etc.).

Site Restoration/Remedial Activities

After the conclusion of the post-operations monitoring period (~50-year), any remaining surface facilities associated with monitoring wells and reservoir access tube will be reclaimed and the area returned to pre-development condition. All gravel pads, access roads, and surface facilities will be removed, and the land will be reclaimed for agricultural or other beneficial pre-construction uses.

Revised Cost Estimates

When revising cost estimates for site closure plugging and abandonment provided by Patrick Engineering in Appendix C of the Class VI UIC Permit, cost estimates (Table 2) were updated to reflect the most recent monitoring well design.

Table 2. Site Closure Summary for All Monitoring Wells and RAT Wells

	Activity	Total Cost ($)
a.	Non-endangerment demonstration	26,000
b.	Lowermost USDW (LUSDW) monitoring well plugging	319,000
c.	Single-Level, In-Reservoir (SLR) monitoring well plugging (5.5” dia.)	487,600
d.	Single-Level, In-Reservoir (SLR) monitoring well plugging (7” dia.)	571,600
e.	Above-Confining Zone monitoring well plugging	858,960
f.	Reservoir Access Tube monitoring well plugging	617,660
g.	Remove surface features and reclaim land	140,000
h.	Document plugging and closure process	17,000
	Total site closure	3,037,820

These estimates are based on plugging and abandonment costs for the following other UIC Permit Applications: 1) Illinois EPA for the FutureGen1 CO_2 injection well (2009), 2)Tenaska CO_2 injection well (2009), 3) Archer Daniel Midland first CO_2 injection well (2011), and 4) the EPA Geologic CO_2 Sequestration Technology and Cost Analysis (Nov. 2011). The following values are an average cost for these line items for well plugging from the four documents above with the values inflated to 2012 dollars. The estimates assume cementing the entire depth of the well.

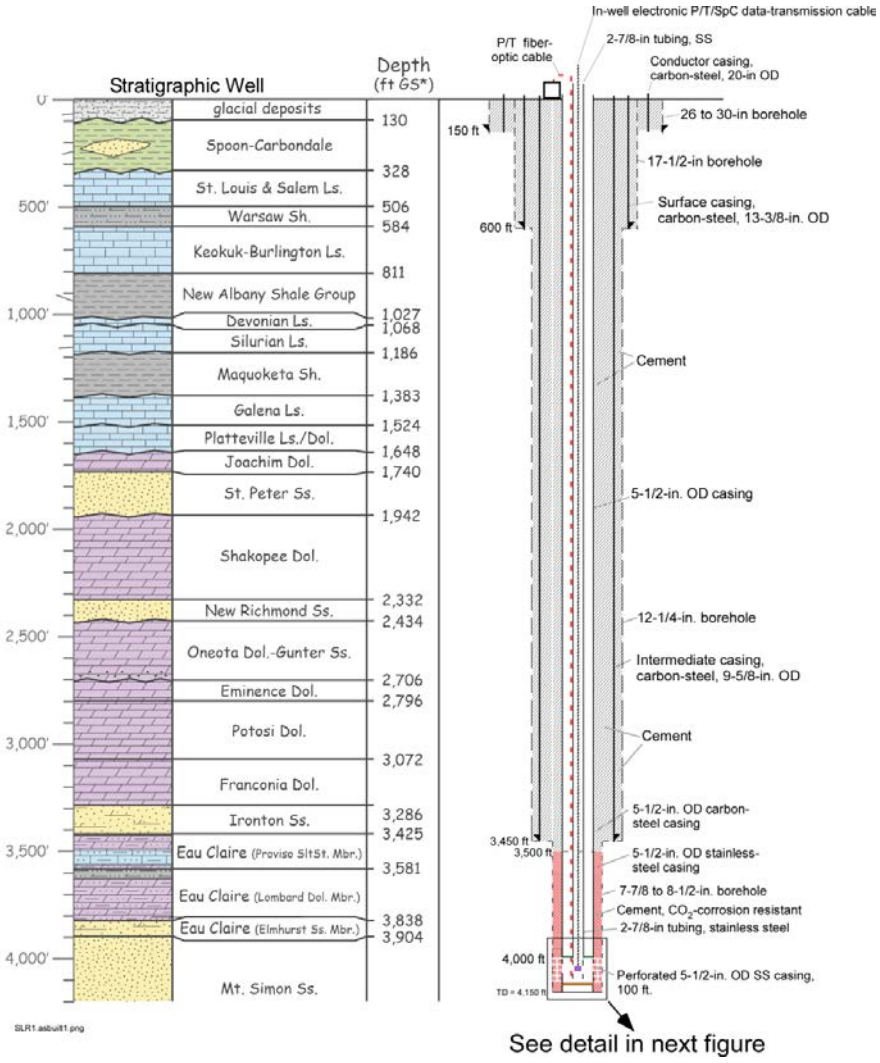
Casing evaluation	$1.77 /in-ft.
Evaluation of any problems discovered by the casing evaluation	$0.57 /in-ft.
Cost for repairing problems & cleanup of any groundwater or soil contamination	$1.19 /in-ft.
Cost for cementing or other materials used to plug the well	$5.30 /in-ft.
Cost for labor, engineering, rig time, equipment and consultants	$4.47 /in-ft.

Updated, third-party, cost-estimate details prepared for each of the different types of wells by Patrick Engineering are presented in Attachment B.

Attachment A.

Planned Construction Designs for

Monitoring Wells and Reservoir Access Tube Wells



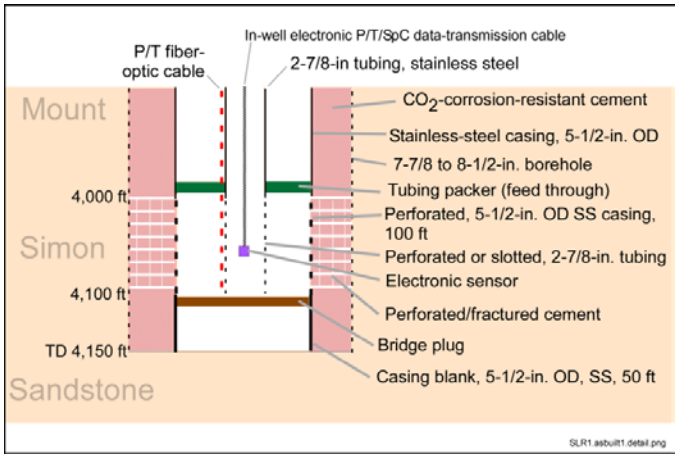
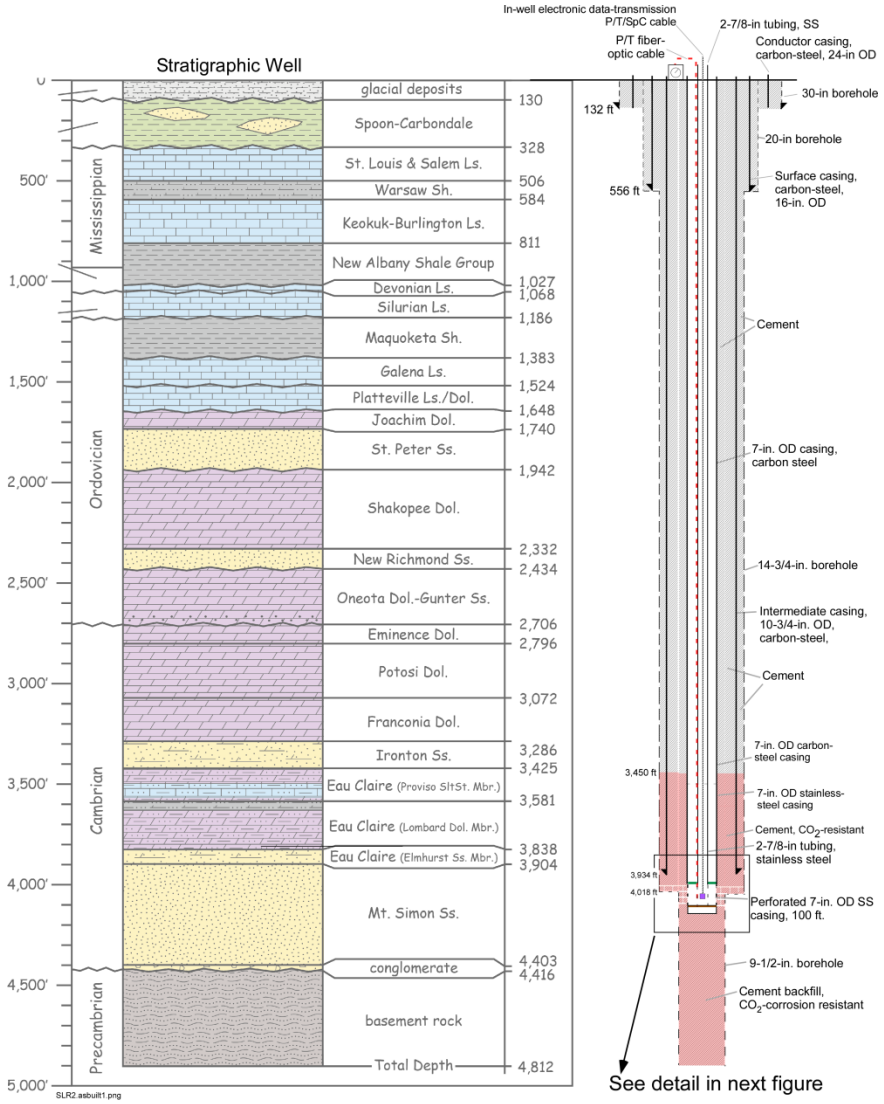


Figure A-1. Planned Well Construction for New 5.5-in.-Diameter Single-Level In-Reservoir Monitoring Well



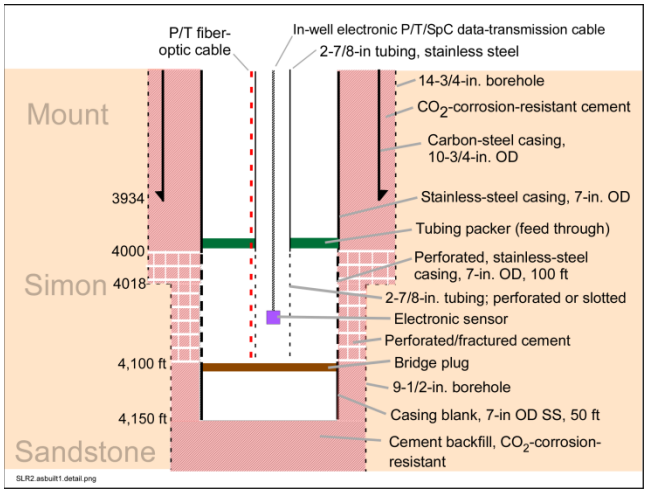
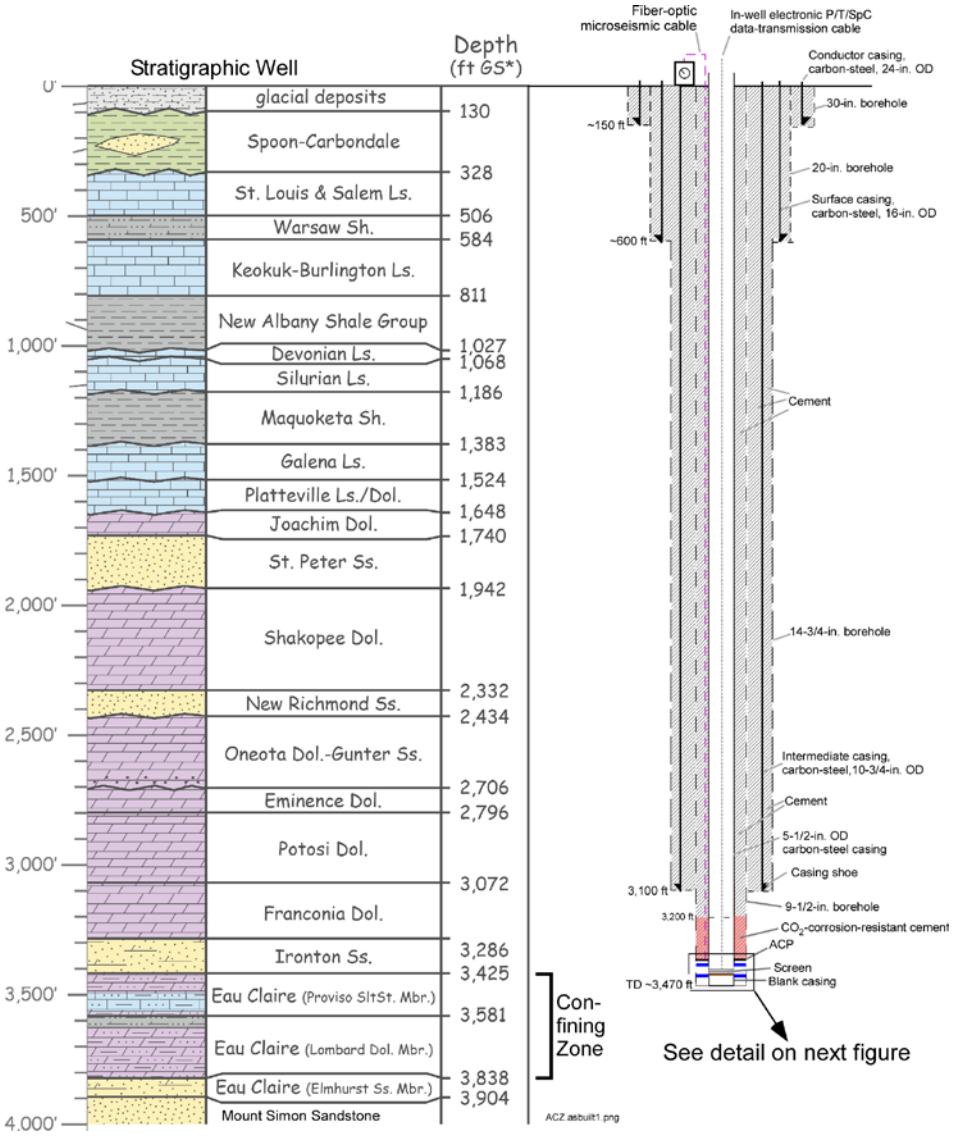


Figure A-2. Planned Well Construction for 7-in.-Diameter Single-Level In-Reservoir Monitoring Well to Be Reconfigured from the Stratigraphic Well



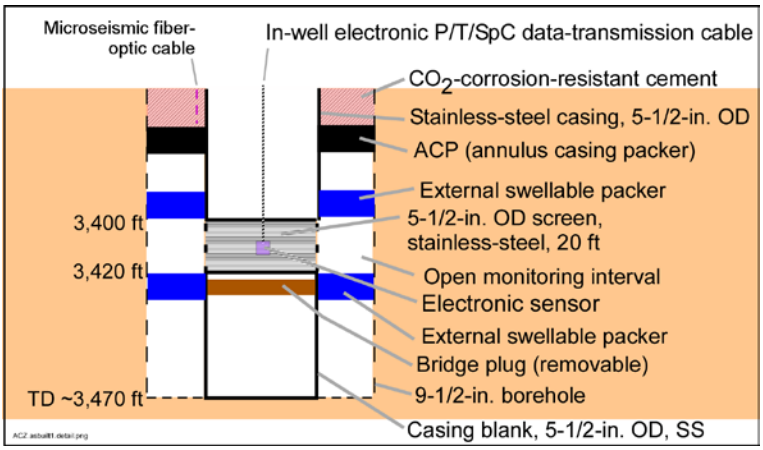
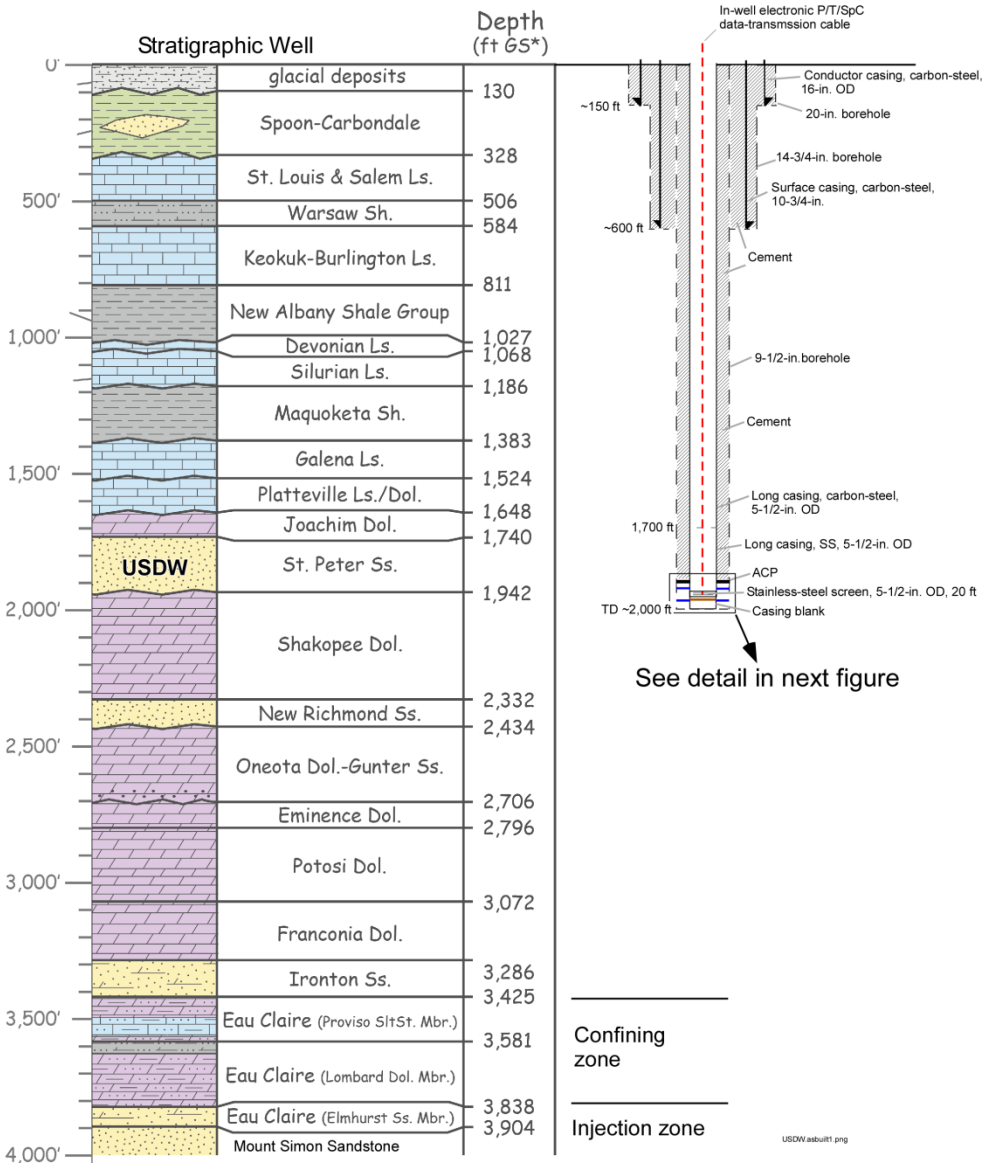


Figure A-3. Planned Well Construction for the Above Confining Zone (ACZ) Monitoring Wells



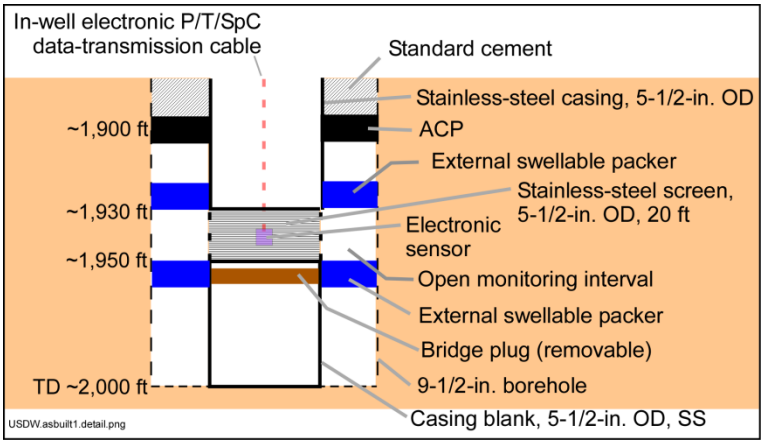


Figure A-4. Planned Well Construction for the USDW Monitoring Well

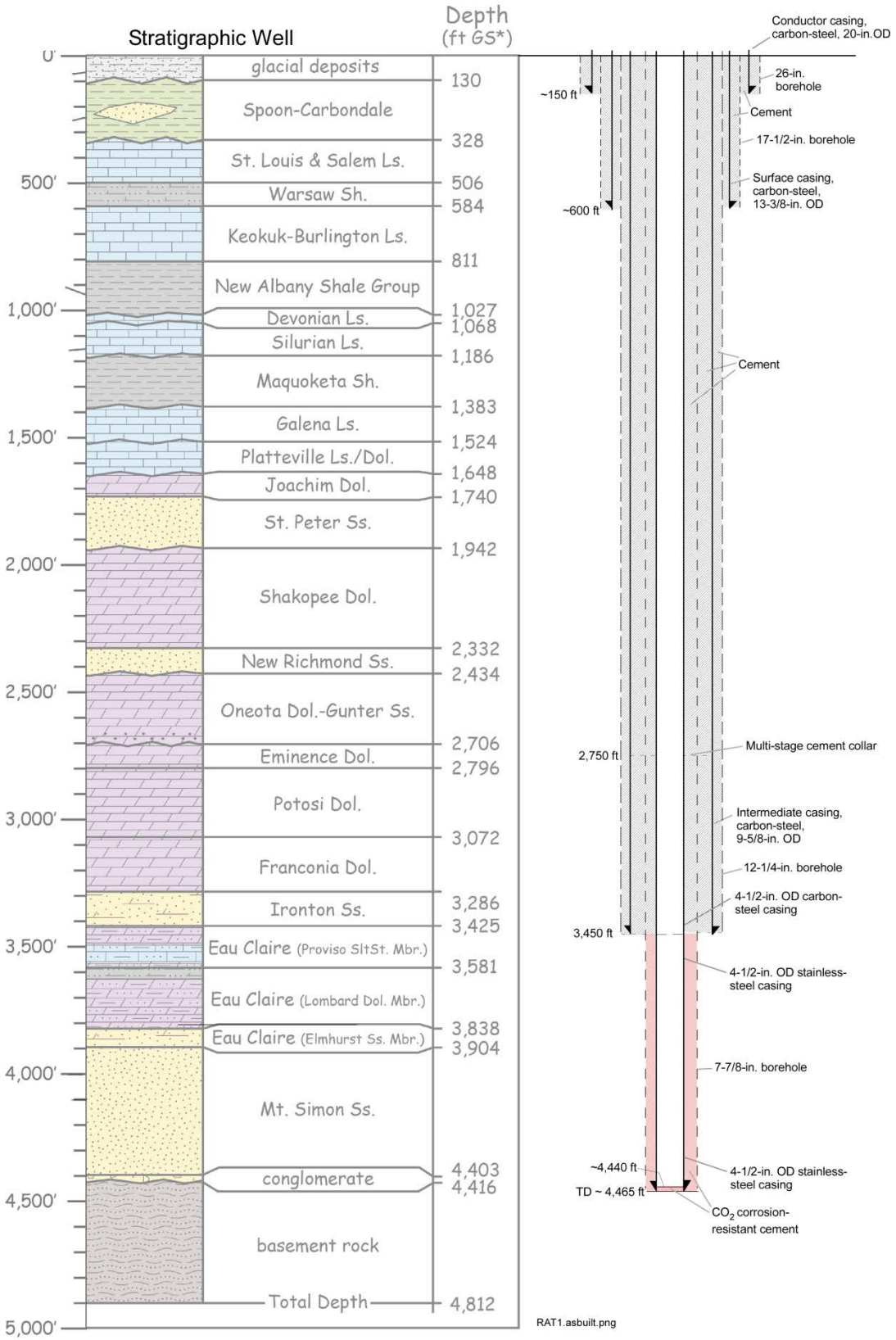


Figure A-5. Planned Construction for the Reservoir Access Tube (RAT) Wells

Attachment B

This is Section IX in Appendix C of the original UIC Permit revised to reflect the updated proposed monitoring network. Footnote 1 explains the cost estimating method.

Cost Estimate to Demonstrate Financial Responsibility for Class VI UIC Permit

(Appendix C, Section IX, Site Closure Cost Estimate)

December 30, 2013

Prepared by:

PATRICK ENGINEERING

IX. Site Closure Cost Estimate

The estimated costs in this section cover the final closure of the site. After the default 50-year, post-injection, and site-care period, and when it could be demonstrated that the project would no longer pose a risk of endangerment to any USDWs, the site would be permanently closed.

The costs are broken into four functional areas: 1) preparing the non-endangerment report; 2) plugging and abandoning all monitoring wells; 3) reclaiming land, including removal of remaining surface site buildings and appurtenances; and 4) documenting the site-closure process. The costs would be one-time costs that would be paid at the final project termination.

The plugging of the monitoring wells would include mechanical integrity testing, plugging the hole with cement the entire depth of the well, and cutting off the well casings below the ground. All structures and appurtenances at the sites of the monitoring wells would be completely removed and the sites would be restored to pre-project conditions.

Well-plugging and site-remediation costs were estimated based on Patrick's experience and costs incurred or estimated for other projects. Three previous UIC applications for CO_2 sequestration wells and DOE documents were reviewed and average costs for mobilization and plugging costs per inch-foot of bore were developed[i].[1]

Table 4. Site Closure Summary

Activity	Total Cost ($)
a. Non-endangerment demonstration	26,000
b. LUSDW monitoring well plugging	319,000
c. Single Level, In Reservoir (SLR) monitoring well plugging (5.5" dia.)	487,600
d. Single Level, In Reservoir (SLR) monitoring well plugging (7" dia.)	571,600
e. Above-Confining Zone monitoring well plugging	858,960
f. Reservoir Access Tube monitoring well plugging	617,660
g. Remove surface features and reclaim land	140,000
h. Document plugging and closure process	17,000
Total site closure	**3,037,820**

[1] UIC Permit Applications to Illinois EPA for the FutureGen1 CO_2 injection well (2009), Tenaska CO_2 injection well (2009), ADM first CO_2 injection well (2011), and EPA Geologic CO_2 Sequestration Technology and Cost Analysis (Nov. 2011). The values below are an average cost for these line items for well plugging from the four documents above with the values inflated to 2012 dollars. The estimates assume cementing the entire depth of the well.

Casing evaluation	$1.77 /in-ft.
Evaluation of any problems discovered by the casing evaluation	$0.57 /in-ft.
Cost for repairing problems & cleanup of any groundwater or soil contamination	$1.19 /in-ft.
Cost for cementing or other materials used to plug the well	$5.30 /in-ft.
Cost for labor, engineering, rig time, equipment and consultants	$4.47 /in-ft.

Table 4a. Site Closure Detail

a. Non-endangerment demonstration			
Activity	**Cost per Well ($)**	**Number of Wells**	**Total Cost ($)**
Prepare non-endangerment demonstration report			26,000
Total cost non-endangerment demonstration			**26,000**

b. LUSDW monitoring well plugging (1900 feet deep)			
Activity	**Cost per Well ($)**	**Number of Wells**	**Total Cost ($)**
Casing evaluation	21,000	1	21,000
Evaluation of any problems discovered by the casing evaluation	7,000	1	7,000
Cost for repairing problems & cleanup of any groundwater or soil contamination	14,000	1	14,000
Cost for cementing or other materials used to plug the well	62,000	1	62,000
Cost for labor, engineering, rig time, equipment and consultants	52,000	1	52,000
Cost for decontamination of equipment	4,000	1	4,000
Cost for disposal of any equipment	2,000	1	2,000
Gravel pad removal (175’ x 175’)	143,000	1	143,000
Project management and oversight (90 hours @ $153/hour)			14,000
Total cost for LUSDW monitoring well plugging			**319,000**

c. Single Level, In Reservoir (SLR) monitoring well plugging (Assumes 1 well 4200 feet deep, 5.5” casing)			
Activity	**Cost per Well ($)**	**Number of Wells**	**Total Cost ($)**
Casing evaluation	41,000	1	41000
Evaluation of any problems discovered by the casing evaluation	13,000	1	13000
Cost for repairing problems & cleanup of any groundwater or soil contamination	28,000	1	28000
Cost for cementing or other materials used to plug the well	122,000	1	122000
Cost for labor, engineering, rig time, equipment and consultants	103,000	1	103000
Cost for decontamination of equipment	4,000	1	4000
Cost for disposal of any equipment	3,000	1	3000
Gravel pad removal (175’ x 175’)	143,000	1	143000
Project management and oversight (200 hours @ $153/hour)			30600
Total cost for SLR (5.5”) monitoring well plugging			**487,600**

d. Single Level, In Reservoir (SLR) monitoring well plugging (Assumes 1 well, 4200 feet deep, 7" casing)			
Activity	**Cost per Well ($)**	**Number of Wells**	**Total Cost ($)**
Casing evaluation	52,000	1	52,000
Evaluation of any problems discovered by the casing evaluation	17,000	1	17,000
Cost for repairing problems & cleanup of any groundwater or soil contamination	35,000	1	35,000
Cost for cementing or other materials used to plug the well	156,000	1	156,000
Cost for labor, engineering, rig time, equipment and consultants	131,000	1	131,000
Cost for decontamination of equipment	4,000	1	4,000
Cost for disposal of any equipment	3,000	1	3,000
Gravel pad removal (175' x 175')	143,000	1	143,000
Project management and oversight (200 hours @ $153/hour)			30,600
Total cost for SLR (7") monitoring well plugging			**571,600**

e. Above Confining Zone (ACZ) monitoring well plugging (3,500 feet deep, 5.5" casing)			
Activity	**Cost per Well ($)**	**Number of Wells**	**Total Cost ($)**
Casing evaluation	34,000	2	68,000
Evaluation of any problems discovered by the casing evaluation	11,000	2	22,000
Cost for repairing problems & cleanup of any groundwater or soil contamination	23,000	2	46,000
Cost for cementing or other materials used to plug the well	102,000	2	204,000
Cost for labor, engineering, rig time, equipment and consultants	86,000	2	172,000
Cost for decontamination of equipment	4,000	2	8,000
Cost for disposal of any equipment	2,000	2	4,000
Gravel pad removal (175' x 175')	143,000	2	286,000
Project management and oversight (320 hours @ $153/hour)			61,200
Total cost for ACZ monitoring wells plugging			**858,960**

f. Reservoir Access Tube (RAT) monitoring well plugging (4500 feet deep, 4.5" casing)			
Activity	**Cost per Well ($)**	**Number of Wells**	**Total Cost ($)**
Casing evaluation	36,000	2	72,000
Evaluation of any problems discovered by the casing evaluation	12,000	2	24,000
Cost for repairing problems & cleanup of any groundwater or soil contamination	24,000	2	48,000
Cost for cementing or other materials used to plug the well	107,000	2	214,000
Cost for labor, engineering, rig time, equipment and consultants	90,000	2	180,000
Cost for decontamination of equipment	4,000	2	8,000
Cost for disposal of any equipment	3,000	2	6,000
Gravel pad removal (25' x 25')	16,000	2	32,000
Project management and oversight (220 hours @ $153/hour)			33,660
Total cost for RAT monitoring wells plugging			**617,660**

g. Surface features removal and land reclamation			
Activity	**Unit Cost ($)**	**Number**	**Total Cost ($)**
Phase II demolition (@ 50 years following cessation of injection) - injection well site 1 well maintenance and monitoring building, and appurtenances	112,000	1	112,000
Remove access roads (miles)	11,000	2.5	28,000
Total cost to remove surface features and reclaim land			**140,000**

h. Documentation			
Activity	**Hours**	**Rate ($/hr)**	**Total Cost ($)**
Document plugging and closure process (well plugging, post-injection plans, notification of intent to close, and post-closure report).	110	153	17,000
Total cost for documentation of well plugging and closure process			**17,000**

Attachment C

Plugging and Abandonment Plans for Monitoring Wells

Plugging and abandonment plans for the following monitoring wells are provided in this attachment:

- ACZ (W)
- ACZ (far W)
- RAT (W)
- RAT (SW)
- SLR (W)-5.5"
- SLR (NE)-7"
- USDW (W)

OMB No. 2040-0042 Approval Expires 11/30/2014

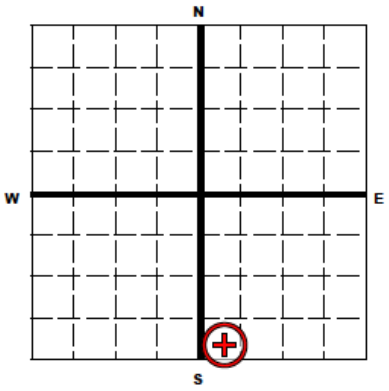
United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility
Well ACZ(W), FutureGen 2.0, Morgan County, IL

Name and Address of Owner/Operator
FutureGen Alliance
73 Central Park Plaza East, Jacksonville, IL 62650

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Illinois	Morgan	

Surface Location Description
sw 1/4 of sw 1/4 of sw 1/4 of se 1/4 of Section 26 Township 16n Range 9w

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ____ ft. frm (N/S) ____ Line of quarter section
and ____ ft. from (E/W) ____ Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Lease Name
Well Number

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
24"	140	0-150	150	30"
16"	84	0-600	600	20"
10-3/4	51	0-3,100	3,100	14.75"
5-1/2"	17	0-3,470	3,470	9.5"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	9.5"	5.5"	5.5"				
Depth to Bottom of Tubing or Drill Pipe (ft.	3,470'	3,350	3,200				
Sacks of Cement To Be Used (each plug)	61	22	447				
Slurry Volume To Be Pumped (cu. ft.)	68	25	528				
Calculated Top of Plug (ft.)	3,350	3,200	0				
Measured Top of Plug (if tagged ft.)	-	-	-				
Slurry Wt. (Lb./Gal.)	15.82	15.82	15.6				
Type Cement or Other Material (Class III)	EverCret	EverCret	Class A				

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
3,470'	3,350' (perforated)		
3,400'	3,420' (screened)		

Estimated Cost to Plug Wells
$429,480

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibliity of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Hard copy with signature to follow		

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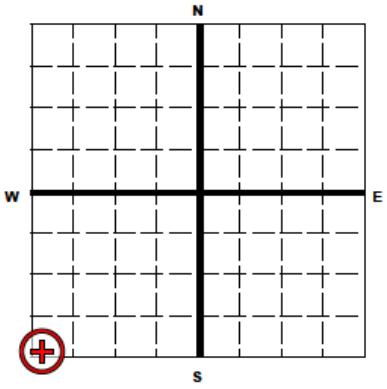
United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility
Well ACZ(far W), FutureGen 2.0, Morgan County, IL

Name and Address of Owner/Operator
FutureGen Alliance
73 Central Park Plaza East, Jacksonville, IL 62650

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Illinois	Morgan	

Surface Location Description
SW 1/4 of SW 1/4 of SW 1/4 of SW 1/4 of Section 26 Township 16n Range 9w

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ___ ft. frm (N/S) ___ Line of quarter section and ___ ft. from (E/W) ___ Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Lease Name
Well Number

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
24"	140	0-150	150	30"
16"	84	0-600	600	20"
10-3/4	51	0-3,100	3,100	14.75"
5-1/2"	17	0-3,470	3,470	9.5"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	9.5"	5.5"	5.5"				
Depth to Bottom of Tubing or Drill Pipe (ft.	3,470'	3,350	3,200				
Sacks of Cement To Be Used (each plug)	61	22	447				
Slurry Volume To Be Pumped (cu. ft.)	68	25	528				
Calculated Top of Plug (ft.)	3,350	3,200	0				
Measured Top of Plug (if tagged ft.)	-	-	-				
Slurry Wt. (Lb./Gal.)	15.82	15.82	15.6				
Type Cement or Other Material (Class III)	EverCret	EverCret	Class A				

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
3,470'	3,350' (perforated)		
3,400'	3,420' (screened)		

Estimated Cost to Plug Wells
$429,480

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibliity of fine and imprisonment. (Ref. 40 CFR 144.32)

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Hard copy with signature to follow		

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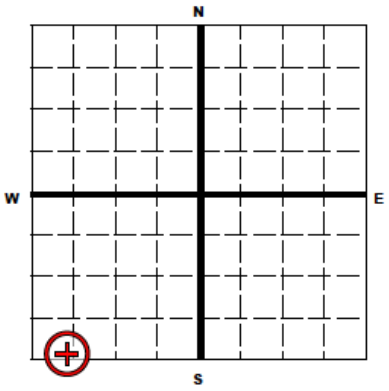
United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility
RAT(W) Well, FutureGen 2.0, Morgan County, IL

Name and Address of Owner/Operator
FutureGen Alliance
73 Central Park Plaza East, Jacksonville, IL 62650

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Illinois	Morgan	

Surface Location Description
se 1/4 of sw 1/4 of sw 1/4 of sw 1/4 of Section 26 Township 16n Range 9w

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ____ ft. frm (N/S) ____ Line of quarter section
and ____ ft. from (E/W) ____ Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Lease Name

Well Number

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
20"	94	0-150	150	26"
13-3/8	61	0-600	600	17.5"
9-5/8"	36	0-3,450	3,450	12.25"
4-1/2"	10.5	0-4,465	4,465	7.875"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	4.5"	4.5"					
Depth to Bottom of Tubing or Drill Pipe (ft.	4,440'	3,450'					
Sacks of Cement To Be Used (each plug)	98	323					
Slurry Volume To Be Pumped (cu. ft.)	109	381					
Calculated Top of Plug (ft.)	3,450'	0'					
Measured Top of Plug (if tagged ft.)	-	-					
Slurry Wt. (Lb./Gal.)	15.82	15.6					
Type Cement or Other Material (Class III)	EverCret	Class A					

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To

Estimated Cost to Plug Wells
$308,830

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibliity of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Hard copy with signature to follow		

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EPA

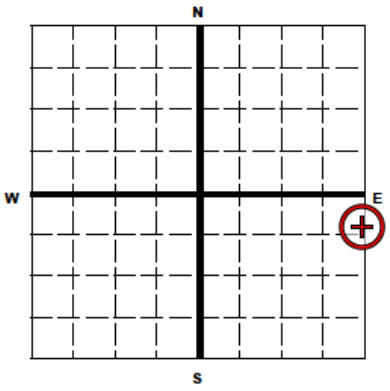
United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility
RAT(SW) Well, FutureGen 2.0, Morgan County, IL

Name and Address of Owner/Operator
FutureGen Alliance
73 Central Park Plaza East, Jacksonville, IL 62650

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Illinois	Morgan	

Surface Location Description
se 1/4 of ne 1/4 of ne 1/4 of se 1/4 of Section 34 Township 16n Range 9w

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ____ ft. frm (N/S) ____ Line of quarter section
and ____ ft. from (E/W) ____ Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Lease Name
Well Number

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
20"	94	0-150	150	26"
13-3/8	61	0-600	600	17.5"
9-5/8"	36	0-3,450	3,450	12.25"
4-1/2"	10.5	0-4,465	4,465	7.875"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	4.5"	4.5"					
Depth to Bottom of Tubing or Drill Pipe (ft.	4,440'	3,450'					
Sacks of Cement To Be Used (each plug)	98	323					
Slurry Volume To Be Pumped (cu. ft.)	109	381					
Calculated Top of Plug (ft.)	3,450	0					
Measured Top of Plug (if tagged ft.)	-	-					
Slurry Wt. (Lb./Gal.)	15.82	15.6					
Type Cement or Other Material (Class III)	EverCret	Class A					

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To

Estimated Cost to Plug Wells
$308,830

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibliity of fine and imprisonment. (Ref. 40 CFR 144.32)

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EPA

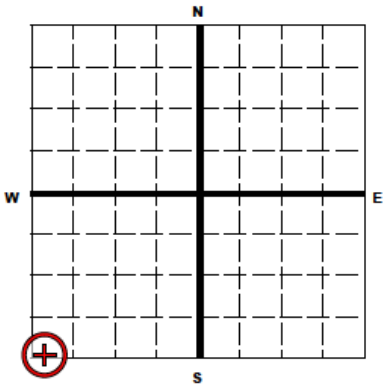
United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility
Well SLR(W), FutureGen 2.0, Morgan County, IL

Name and Address of Owner/Operator
FutureGen Alliance
73 Central Park Plaza East, Jacksonville, IL 62650

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Illinois	Morgan	

Surface Location Description
SW 1/4 of SW 1/4 of SW 1/4 of SW 1/4 of Section 26 Township 16n Range 9w

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ____ ft. frm (N/S) ____ Line of quarter section
and ____ ft. from (E/W) ____ Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Lease Name
Well Number

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
20"	94	0-150	150	26"
13-3/8	61	0-600	600	17.5"
9-5/8"	36	0-3,450	3,450	12.25"
5-1/2"	17	0-4,150	4,150	8"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	5-1/2"	5-1/2"					
Depth to Bottom of Tubing or Drill Pipe (ft.	4,150'	3,500'					
Sacks of Cement To Be Used (each plug)	98	489					
Slurry Volume To Be Pumped (cu. ft.)	110	577					
Calculated Top of Plug (ft.)	3,500'	0'					
Measured Top of Plug (if tagged ft.)	-	-					
Slurry Wt. (Lb./Gal.)	15.82	15.6					
Type Cement or Other Material (Class III)	EverCret	Class A					

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
4000'	4100' (perforated and fractured)		

Estimated Cost to Plug Wells
$536,600

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibliity of fine and imprisonment. (Ref. 40 CFR 144.32)

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Hard copy with signature to follow		

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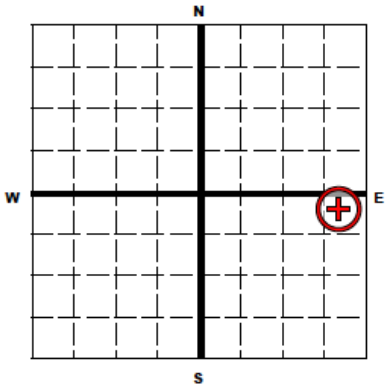
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility	Name and Address of Owner/Operator
Well SLR(NE), FutureGen 2.0, Morgan County, IL	FutureGen Alliance 73 Central Park Plaza East, Jacksonville, IL 62650

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Illinois	Morgan	

Surface Location Description

nw 1/4 of ne 1/4 of ne 1/4 of se 1/4 of Section 25 Township 16n Range 9w

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ____ ft. frm (N/S) ____ Line of quarter section and ____ ft. from (E/W) ____ Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Lease Name ____ Well Number ____

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
24"	140	0-132	132	30"
16"	84	0-556	556	20"
10-3/4	51	0-3,934	3,934	14.75"
7"	29	4,150	4,150	9.5"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	7"	7"					
Depth to Bottom of Tubing or Drill Pipe (ft.	4,150'	3,500'					
Sacks of Cement To Be Used (each plug)	159	793					
Slurry Volume To Be Pumped (cu. ft.)	178	935					
Calculated Top of Plug (ft.)	3,500'	0'					
Measured Top of Plug (if tagged ft.)	-	-					
Slurry Wt. (Lb./Gal.)	15.82	15.6					
Type Cement or Other Material (Class III)	EverCret	Class A					

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
4000'	4100' (perforated and fractured)		

Estimated Cost to Plug Wells: $571,600

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibliity of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Hard copy with signature to follow		

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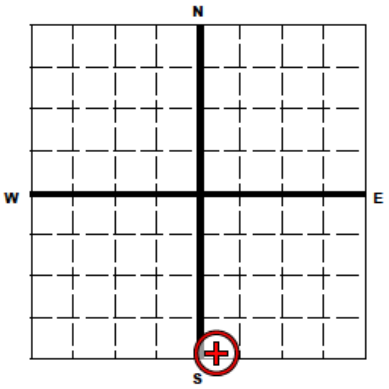
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility	Name and Address of Owner/Operator
Well USDW(W), FutureGen 2.0, Morgan County, IL	FutureGen Alliance 73 Central Park Plaza East, Jacksonville, IL 62650

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Illinois	Morgan	

Surface Location Description

sw 1/4 of sw 1/4 of sw 1/4 of se 1/4 of Section 26 Township 16n Range 9w

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ___ ft. frm (N/S) ___ Line of quarter section and ___ ft. from (E/W) ___ Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Lease Name ____ Well Number ____

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
16"	55	0-150	150	20"
10-3/4	40.5	0-600	600	14.75"
5-1/2"	17	0-2,000	2,000	9.5"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	9.5"	5.5"					
Depth to Bottom of Tubing or Drill Pipe (ft.	2,000'	1,880'					
Sacks of Cement To Be Used (each plug)	61	263					
Slurry Volume To Be Pumped (cu. ft.)	68	310					
Calculated Top of Plug (ft.)	1,880'	0					
Measured Top of Plug (if tagged ft.)	-	-					
Slurry Wt. (Lb./Gal.)	15.6	15.6					
Type Cement or Other Material (Class III)	Class A	Class A					

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
2,000'	1,880' (perforated)		
1,930'	1,950' (screened)		

Estimated Cost to Plug Wells

$319,000

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibliity of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Hard copy with signature to follow		

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